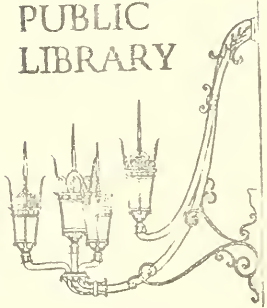
BOSTON
PUBLIC
LIBRARY



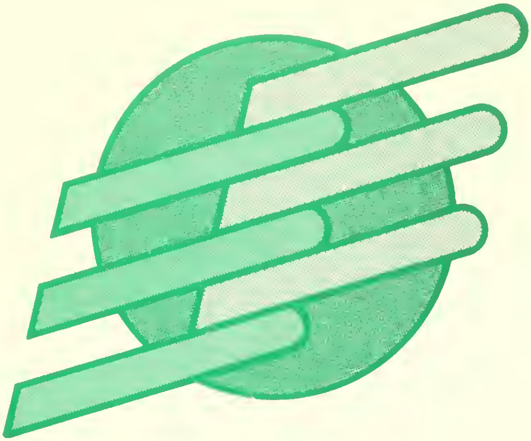
Boston Edison Company

NEW BOSTON STATION
UNITS 1 AND 2

COAL CONVERSION PROJECT

DRAFT ENVIRONMENTAL IMPACT REPORT

GOVDOC
BRA
1716
Vol.2



VOLUME 2

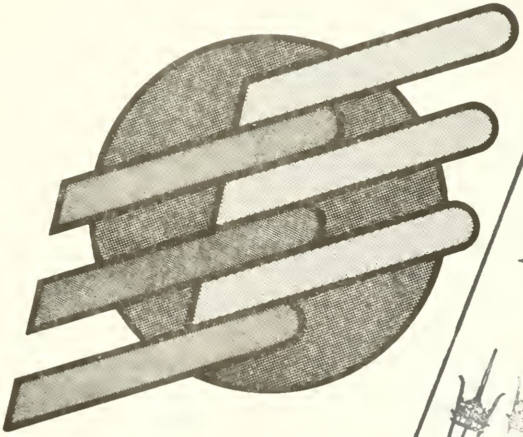
STONE & WEBSTER ENGINEERING CORPORATION

Boston Edison Company

NEW BOSTON STATION UNITS 1 AND 2

COAL CONVERSION PROJECT

DRAFT ENVIRONMENTAL IMPACT REPORT



BOSTON
PUBLIC
LIBRARY

VOLUME 2

STONE & WEBSTER ENGINEERING CORPORATION

TABLE OF CONTENTS

Section	Title	Page
1	DOCUMENTS RELATIVE TO THE PREPARATION OF THE ENVIRONMENTAL IMPACT REPORT	1.0-1
1.1	ENVIRONMENTAL NOTIFICATION FORM	1.1-1
1.2	ENVIRONMENTAL IMPACT REPORT SCOPE DOCUMENTS	1.2-1
2	PROJECT SUMMARY	2.1-1
2.1	PROJECT IDENTIFICATION	2.2-1
2.2	PROJECT DESCRIPTION AND HISTORY	2.2-1
2.3	SUMMARY OF ENVIRONMENTAL IMPACTS	2.3-1
2.4	COST-BENEFIT SUMMARY	2.4-1
2.4.1	Major Benefits	2.4-1
2.4.2	Major Costs	2.4-1
3	ENVIRONMENTAL, STATUTORY, AND REGULATORY REQUIREMENTS	3.0-1
3.1	REQUIREMENTS	3.1-1
3.1.1	Air Quality	3.1-1
3.1.1.1	State Implementation Plan (SIP)	3.1-2
3.1.1.2	New Source Performance Standards	3.1-2
3.1.1.3	Prevention of Significant Deterioration (PSD)	3.1-4
3.1.1.4	Good Engineering Practice	3.1-4
3.1.1.5	National Emission Standards for Hazardous Air Pollutants (NESHAP)	3.1-4
3.1.2	Water Quality	3.1-5
3.1.2.1	National Pollutant Discharge Elimination System (NPDES)	3.1-5
3.1.3	Solid Waste	3.1-7
3.1.4	Marine Environment	3.1-8
3.1.5	Aviation Safety	3.1-9
3.1.6	National Environmental Policy Act (NEPA) Requirements	3.1-9
3.1.7	Reference	3.1-11
3.2	STATE REQUIREMENTS	3.2-1
3.2.1	Air Quality	3.2-1
3.2.1.1	State Implementation Plan	3.2-1
3.2.1.2	New Source Performance Standards (NSPS)	3.2-3

TABLE OF CONTENTS (Cont)

Section	Title	Page
3.2.1.3	Prevention of Significant Deterioration (PSD) and Non-attainment Review	3.2-4
3.2.1.4	Good Engineering Practice Stack (or Chimney) Height Requirements	3.2-5
3.2.1.5	Air Plans Approval.	3.2-6
3.2.1.6	Notification of Intent to Demolish a Structure Containing Asbestos Covered Material.	3.2-6
3.2.1.7	National Emission Standard for Hazardous Air Pollutants (NESHAP)	3.2-6
3.2.2	Water Quality	3.2-6
3.2.2.1	National Pollutant Discharge Elimination System (NPDES) Permit Modification	3.2-6
3.2.2.2	Water Quality Certification	3.2-6
3.2.2.3	Industrial Waste Treatment Facilities Permit. .	3.2-7
3.2.3	Solid Waste	3.2-7
3.2.4	Marine Environment.	3.2-8
3.2.4.1	Chapter 91 Waterways License.	3.2-8
3.2.4.2	Coastal Zone Management (CZM): Concurrence with Consistency Certification	3.2-8
3.2.5	Massachusetts Environmental Policy Act (MEPA) Requirements.	3.2-9
3.2.6	Department of Public Utilities (DPU).	3.2-10
3.2.7	Reference	3.2-10
3.3	LOCAL REQUIREMENTS.	3.3-1
4	DESCRIPTION OF EXISTING FACILITY AND ENVIRONS .	4.1-1
4.1	CHARACTERISTICS OF SITE	4.1-1
4.2	DESCRIPTION OF ENVIRONS	4.2-1
4.2.1	Physiography, Topography, and Geology	4.2-1
4.2.2	Land Use and Water Use.	4.2-2
4.2.2.1	Land Use - Site Vicinity.	4.2-2
4.2.2.2	Land Use - Onsite	4.2-3
4.2.2.3	Water Use	4.2-3
4.2.3	References.	4.2-4
4.3	POPULATION AND SENSITIVITY RECEPTORS.	4.3-1
4.4	SOCIOECONOMICS.	4.4-1
4.4.1	Transportation.	4.4-1
4.4.1.1	Road System	4.4-1
4.4.1.2	Rail System	4.4-2
4.4.2	Traffic Conditions.	4.4-2

TABLE OF CONTENTS (Cont)

Section	Title	Page
4.4.2.1	Road System	4.4-2
4.4.2.2	Traffic Safety	4.4-3
4.4.3	Labor	4.4-3
4.4.3.1	Offsite	4.4-3
4.4.3.2	Onsite	4.4-4
4.4.4	Economics	4.4-4
4.4.5	Public Facilities and Services	4.4-5
4.4.5.1	Recreation	4.4-5
4.4.5.2	Education	4.4-5
4.4.5.3	Police and Fire Protection	4.4-5
4.4.5.4	Health Services	4.4-5
4.4.5.5	Utilities	4.4-6
4.4.6	Housing	4.4-6
4.4.7	References	4.4-7
4.5	FEATURES OF HISTORICAL AND ARCHAEOLOGICAL INTEREST	4.5-1
4.5.1	Description	4.5-1
4.5.2	References	4.5-1
4.6	SCENIC AND CULTURAL QUALITY OF THE AREA	4.6-1
4.7	DESCRIPTION OF EXISTING FACILITY	4.7-1
4.7.1	Site Layout	4.7-1
4.7.2	Fuel Supply System	4.7-1
4.7.3	Power Generation System	4.7-2
4.7.4	Cooling Water Systems	4.7-2
4.7.5	Pollution Control Equipment	4.7-3
4.7.6	Station Wastes and Their Disposal	4.7-4
4.7.7	Station Operation	4.7-5
4.7.7.1	Boston Edison Company Service Area	4.7-5
4.7.7.2	Power Dispatch	4.7-5
4.7.7.3	Mode of Station Operation	4.7-6
4.7.7.4	General Operating Procedures	4.7-7
5	DESCRIPTION OF THE EXISTING ENVIRONMENT	5.1-1
5.1	CLIMATOLOGY	5.1-1
5.2	METEOROLOGY	5.2-1
5.2.1	Precipitation	5.2-1
5.2.2	Temperature	5.2-1
5.2.3	Fog	5.2-1
5.2.4	Relative Humidity	5.2-1

TABLE OF CONTENTS (Cont)

Section	Title	Page
5.2.5	Wind Speed and Direction.	5.2-2
5.3	AIR QUALITY	5.3-1
5.3.1	Criteria Pollutants	5.3-2
5.3.1.1	Ambient Air Quality Data for Criteria Pollutants.	5.3-2
5.3.1.2	Emissions of Criteria Pollutants from New Boston Station.	5.3-9
5.3.1.3	Future Trends in Air Quality for Criteria Pollutants.	5.3-11
5.3.2	Noncriteria Pollutants.	5.3-13
5.3.2.1	Ambient Air Quality Data for Noncriteria Pollutants.	5.3-14
5.3.2.2	Emissions of Noncriteria Pollutants from New Boston Station.	5.3-17
5.3.2.3	Future Trends in Air Quality for Noncriteria Pollutants.	5.3-17
5.3.3	References.	5.3-18
5.4	SURFACE WATER HYDROLOGY AND QUALITY	5.4-1
5.4.1	Surface Water Hydrology	5.4-1
5.4.2	Surface Water Quality	5.4-1
5.4.2.1	Receiving Water Quality Standards	5.4-2
5.4.2.2	Water Quality Parameters.	5.4-2
5.4.2.3	Data Base and Location of Sampling Stations . .	5.4-2
5.4.2.4	Water Quality in Boston Harbor and the Reserved Channel near New Boston Station	5.4-2
5.4.2.5	Surface Water Quality Summary	5.4-6
5.4.3	References.	5.4-7
5.5	GROUNDWATER HYDROLOGY AND QUALITY	5.5-1
5.5.1	Groundwater Hydrology	5.5-1
5.5.2	Groundwater Quality	5.5-2
5.5.2.1	Groundwater Quality Standards	5.5-2
5.5.2.2	Groundwater Quality Parameters.	5.5-2
5.5.2.3	Groundwater Quality at New Boston Station . . .	5.5-2
5.5.2.4	Groundwater Quality Summary	5.5-3
5.5.3	References.	5.5-3
5.6	TERRESTRIAL AND AQUATIC ECOSYSTEMS.	5.6-1
5.6.1	Terrestrial Ecology	5.6-1
5.6.1.1	Regional Characteristics and Physiognomy. . . .	5.6-1
5.6.1.2	Site Vicinity Vegetation.	5.6-1

TABLE OF CONTENTS (Cont)

Section	Title	Page
5.6.1.3	Regional Wildlife	5.6-2
5.6.1.4	Environmental Stresses	5.6-5
5.6.2	Aquatic Ecology	5.6-6
5.6.2.1	Introduction	5.6-6
5.6.2.2	Invertebrates	5.6-6
5.6.2.3	Finfish	5.6-7
5.6.2.4	Endangered and Threatened Species	5.6-7
5.6.3	References	5.6-8
5.7	AMBIENT NOISE LEVELS	5.7-1
5.7.1	Station and Community Description	5.7-1
5.7.2	Applicable Regulations	5.7-2
5.7.3	Ambient Sound Level Survey Methodology	5.7-2
5.7.4	Sound Level Survey Results	5.7-4
5.7.5	Community Measurements	5.7-5
5.7.6	Summary	5.7-8
5.8	GENERAL OVERVIEW OF ACID PRECIPITATION	5.8-1
5.8.1	Introduction	5.8-1
5.8.2	Acid Precipitation	5.8-1
5.8.3	Sources	5.8-2
5.8.4	Chemical Transformations	5.8-2
5.8.5	Transport and Deposition Mechanisms	5.8-3
5.8.6	Effects on Aquatic Ecology	5.8-3
5.8.7	Effects on Terrestrial Ecology	5.8-5
5.8.8	Summary	5.8-6
5.8.9	Bibliography	5.8-6
6	DESCRIPTION OF THE PROPOSED PROJECT	6.1-1
6.1	OBJECTIVES OF THE PROPOSED PROJECT	6.1-1
6.2	CHARACTERISTICS OF THE PROPOSED PROJECT	6.2-1
6.2.1	Site	6.2-2
6.2.1.1	Demolition Work	6.2-2
6.2.1.2	Construction Laydown and Parking	6.2-3
6.2.2	Chimney	6.2-4
6.2.3	Electrostatic Precipitators and Draft System	6.2-4
6.2.4	Fly Ash Handling System	6.2-5
6.2.5	Boiler Changes	6.2-6
6.2.6	Bottom Ash Handling System	6.2-7
6.2.7	Coal Receiving, Handling, and Storage Facilities	6.2-8
6.2.7.1	Waterfront Berthing Facility	6.2-8

TABLE OF CONTENTS (Cont)

Section	Title	Page
6.2.7.2	Berthing Basin Construction	6.2-8
6.2.7.3	Active Coal Receiving, Handling, and Storage	6.2-9
6.2.7.4	Reserve Coal Storage/Handling	6.2-10
6.2.8	Wastewater Treatment and Disposal System	6.2-11
6.2.9	Solid Waste Management Plan	6.2-13
6.3	COST-BENEFITS DESCRIPTION	6.3-1
6.3.1	Major Project Benefits	6.3-1
6.3.2	Major Project Costs	6.3-1
6.3.3	References	6.3-2
6.4	PROJECT SCHEDULE	6.4-1
6.5	VISUAL RENDERINGS	6.5-1
7	ESTIMATED IMPACTS OF THE PROPOSED PROJECT	7.1-1
7.1	AIR QUALITY IMPACTS	7.1-1
7.1.1	Construction Phase Air Quality Impacts	7.1-1
7.1.1.1	Fugitive Dust	7.1-1
7.1.1.2	Volatile Organic Compounds (VOCs)	7.1-3
7.1.2	Operational Phase Air Quality Impacts	7.1-3
7.1.2.1	Emissions from New Boston Station	7.1-4
7.1.2.1.1	Criteria Pollutants	7.1-5
7.1.2.1.2	Noncriteria Pollutants	7.1-9
7.1.2.2	Dispersion Modeling	7.1-12
7.1.2.3	Ambient Impact Analysis	7.1-16
7.1.2.3.1	Criteria Pollutants	7.1-16
7.1.2.3.2	Noncriteria Pollutants	7.1-22
7.1.2.4	Local/Regional/National/International Effects of Acid Precipitation	7.1-24
7.1.3	References	7.1-26
7.2	NOISE IMPACTS	7.2-1
7.2.1	Construction Phase Noise Impacts	7.2-1
7.2.1.1	Demolition	7.2-1
7.2.1.2	Traffic	7.2-2
7.2.1.3	Establishing the Reserve Coal Pile	7.2-2
7.2.1.4	Working at Night	7.2-2
7.2.2	Operational Phase Noise Impacts	7.2-3
7.2.2.1	Main Plant Area	7.2-3
7.2.2.2	Coal Unloading and Handling Area	7.2-3
7.2.2.3	Traffic	7.2-4

TABLE OF CONTENTS (Cont)

Section	Title	Page
7.3	WATER IMPACTS	7.3-1
7.3.1	Construction Phase Water Impacts	7.3-1
7.3.1.1	Water Quality	7.3-1
7.3.1.2	Hydrology	7.3-2
7.3.1.3	Waterway System	7.3-3
7.3.1.4	Dredging in Reserved Channel	7.3-4
7.3.1.5	Aquatic Ecology	7.3-4
7.3.2	Operational Phase Water Impacts	7.3-5
7.3.2.1	Surface Water Quality	7.3-5
7.3.2.2	Hydrology	7.3-9
7.3.2.3	Groundwater Quality and Hydrology	7.3-10
7.3.2.4	Aquatic Ecology Impacts	7.3-11
7.3.2.5	Waterway System	7.3-12
7.3.3	References	7.3-13
7.4	LAND IMPACTS	7.4-1
7.4.1	Construction Phase Land Impacts	7.4-1
7.4.1.1	Site Area	7.4-1
7.4.1.2	Road Traffic	7.4-1
7.4.1.3	Construction Laydown and Parking	7.4-4
7.4.1.4	Terrestrial Ecology	7.4-4
7.4.2	Operational Phase Land Impacts	7.4-5
7.4.2.1	Land Use	7.4-5
7.4.2.2	Road Traffic and Parking	7.4-6
7.4.2.3	Terrestrial Ecology	7.4-6
7.4.2.4	Waterfront	7.4-10
7.4.3	References	7.4-10
7.5	SOCIOECONOMIC IMPACTS	7.5-1
7.5.1	Construction Phase Socioeconomic Impacts	7.5-1
7.5.2	Long-Term Socioeconomic Impacts	7.5-1
7.5.2.1	Property Values	7.5-1
7.5.2.2	Economic Development of South Boston	7.5-1
7.5.3	References	7.5-4
7.6	AESTHETIC IMPACT	7.6-1
7.6.1	Station Structures Impact	7.6-1
7.6.2	Visual Impact	7.6-2
7.6.3	Reference	7.6-4

TABLE OF CONTENTS (Cont)

Section	Title	Page
8	SOLID WASTE MANAGEMENT PLAN	8.1-1
8.1	CONSTRUCTION PERIOD	8.1-1
8.1.1	Demolition Wastes	8.1-1
8.1.2	Construction Refuse	8.1-1
8.1.3	Dredged Material	8.1-1
8.2	OPERATIONAL PERIOD	8.2-1
8.2.1	Coal Ash Management	8.2-1
8.2.1.1	Introduction	8.2-1
8.2.1.2	Short-Term Management	8.2-4
8.2.1.3	Long-Term Managment	8.2-5
8.2.1.4	Ash Transportation	8.2-8
8.2.2	Alternatives to Ash Disposal - Ash Reuse	8.2-14
8.2.3	Long-Term Disposal Commitments	8.2-15
8.2.4	Wastewater Treatment Sludge and General Refuse Disposal	8.2-16
8.2.4.1	Station Wastewater Treatment Sludge (Solid Wastes)	8.2-16
8.2.4.2	General Refuse	8.2-17
8.2.5	References	8.2-17
9	ALTERNATIVES TO THE PROPOSED PROJECT	9.1-1
9.1	NO CHANGE	9.1-1
9.2	NEW CHIMNEY WITH 2.2 PERCENT SULFUR OIL	9.2-1
9.3	PROPOSED PROJECT WITH DIFFERENT COALS	9.3-1
9.3.1	1 Percent Sulfur Coal	9.3-1
9.3.2	0.7 Percent Sulfur Coal	9.3-2
9.3.3	Lower Ash Content Coal	9.3-2
9.3.4	Reference	9.3-3
9.4	USE OF NATURAL GAS	9.4-1
9.5	ALTERNATIVE OR ADDITIONAL ADVANCED POLLUTION CONTROL TECHNOLOGIES	9.5-1
9.5.1	Flue Gas Scrubbers	9.5-1
9.5.1.1	Wet Scrubbers	9.5-2
9.5.1.2	Dry Scrubbers	9.5-3
9.5.1.3	Partial Scrubbing	9.5-3
9.5.2	Baghouse Particulate Collectors	9.5-4

TABLE OF CONTENTS (Cont)

Section	Title	Page
9.5.3	Fluidized Bed Combustion.	9.5-4
9.5.4	Limestone Injection	9.5-5
9.5.5	Special Controls for Particulates from Soot Blowing.	9.5-6
9.5.6	References.	9.5-7
9.6	PURCHASE ELECTRICITY.	9.6-1
9.7	PHASE OUT NEW BOSTON STATION.	9.7-1
9.8	CONSTRUCT NEW SUBURBAN OR RURAL FACILITY. . . .	9.8-1
9.9	USE OF COAL/WATER MIXTURE	9.9-1
10	HEALTH IMPACTS OF PROPOSED ACTION AND ALTERNATIVES.	10.1-1
10.1	SUMMARY	10.1-1
10.2	METHODOLOGY FOR EVALUATION OF HEALTH IMPACTS	10.2-1
10.3	CURRENT HEALTH STATUS OF SOUTH BOSTON	10.3-1
10.4	HEALTH IMPACTS OF PROPOSED ACTION	10.4-1
10.4.1	Criteria Pollutants	10.4-1
10.4.1.1	Sulfur Oxides/Total Suspended Particulates. . .	10.4-1
10.4.1.2	Nitrogen Oxides and Photochemical Oxidants. . .	10.4-2
10.4.1.3	Carbon Monoxide (CO).	10.4-4
10.4.1.4	Lead.	10.4-4
10.4.2	Noncriteria Pollutants.	10.4-4
10.4.2.1	Respirable Particulate Matter (RPM)	10.4-4
10.4.2.2	Trace Elements.	10.4-5
10.4.2.3	Polycyclic Organic Matter (POM)	10.4-6
10.4.2.4	Radionuclides	10.4-7
10.4.3	References.	10.4-8
10.5	COMPARATIVE HEALTH IMPACTS OF ALTERNATIVES. . .	10.5-1
10.6	CONCLUSIONS	10.6-1
11	PROPOSED MEASURES TO MINIMIZE ENVIRONMENTAL IMPACTS	11.1-1
11.1	CONSTRUCTION PERIOD MITIGATION MEASURES	11.1-1

TABLE OF CONTENTS (Cont)

Section	Title	Page
11.1.1	Noise Control	11.1-1
11.1.2	Traffic and Parking Control	11.1-2
11.1.3	Fugitive Dust Suppression	11.1-3
11.1.4	Erosion and Sediment Control	11.1-4
11.1.5	Construction Wastes Disposal	11.1-5
11.1.6	References	11.1.5
11.2	OPERATIONAL PERIOD MITIGATION MEASURES	11.2-1
11.2.1	Coal Handling and Storage Controls	11.2-1
11.2.1.1	Coal Spillage Control	11.2-1
11.2.1.2	Noise Control for Coal Handling Equipment	11.2-1
11.2.1.3	Fugitive Dust Suppression	11.2-2
11.2.1.4	Fire Protection	11.2-3
11.2.1.5	Operation with Reduced Reserve Coal Storage	11.2-4
11.2.2	Precombustion Controls	11.2-5
11.2.2.1	Coal Washing	11.2-5
11.2.2.2	Combustion Controls	11.2-5
11.2.3	Postcombustion Control	11.2-6
11.2.3.1	Electrostatic Precipitators	11.2-6
11.2.3.2	Chimney	11.2-7
11.2.4	Onsite Ash Handling and Storage Controls	11.2-8
11.2.4.1	Fly Ash System Controls	11.2-8
11.2.4.2	Bottom Ash System Controls	11.2-8
11.2.5	Wastewater Collection, Treatment, and Disposal Measures	11.2-9
11.2.6	Aesthetic Enhancement	11.2-10
11.2.7	Solid Waste Transportation and Disposal Control	11.2-11
11.2.7.1	Truck Transport	11.2-12
11.2.7.2	Rail Transport	11.2-13
11.2.7.3	Barge Transport	11.2-13
11.2.7.4	Ash Disposal	11.2-13
11.2.8	Fugitive Dust Emission Controls	11.2-13
11.2.9	Other Station Noise Control	11.2-14
11.2.10	References	11.2-15
12	AMBIENT AIR QUALITY MONITORING PROGRAM	12.1-1
12.1	EXISTING AMBIENT AIR QUALITY MONITORING PROGRAMS	12.1-1
12.2	MONITORING PROGRAMS ASSOCIATED WITH THE PROPOSED PROJECT	12.2-1
12.2.1	Ambient Air Quality Monitoring	12.2-1
12.2.2	Emission Monitoring	12.2.3

TABLE OF CONTENTS (Cont)

Section	Title	Page
APPENDICES		
A	PAST AND PRESENT BASELINE ENVIRONMENTAL ISSUES L STREET/NEW BOSTON STATION	A-1
B	CORRESPONDENCE WITH AGENCIES	B-1
C	AN EVALUATION OF SULFUR CONTENT FUEL FOR USE AT MYSTIC AND NEW BOSTON STATIONS	C-1
D	ATMOSPHERIC DISPERSION REMODELING WITH REFINED CONCEPTUAL DESIGNS	D-1
E	ASH TRANSOPORTATION FOR NEW BOSTON STATION COAL CONVERSION	E-1
F	INITIAL MARKET ASSESSMENT: BOSTON EDISON COAL ASH	F-1
G	SEDIMENT SAMPLING AND ANALYSIS PROTOCOL	G-1

LIST OF TABLES

Table	Title
3.0-1	Principal Federal, State, and Local Regulatory Programs and Requirements, New Boston Station Coal Conversion
3.1-1	Standards of Performance Steam Electric Generating Units
3.1-2	Allowable Prevention of Significant Deterioration Increments
3.1-3	Waste Streams from New Boston Station
3.1-4	Existing NPDES Water Quality Limitations for New Boston Station
3.2-1	Particulate Emission Limitations Fossil Fuel Utilization Facilities
3.2-2	Significant Ambient Air Quality Impacts (ug/m^3)
3.2-3	Significant Air Pollutant Emissions (tons/year)
4.2-1	South Boston Land Use by Zone
4.2-2	Boston Harbor Commerce Vessel Traffic, 1980
4.3-1	Percent Distribution of South Boston Households By Size, 1980
4.3-2	Population Distribution Within 5500 Feet of New Boston Station
4.3-3	Sensitive Receptors in South Boston
4.4-1	Existing Levels of Service for Selected Intersections in South Boston
4.4-2	Traffic Movement Summary at Intersection of East First and Summer Streets
4.4-3	Average Weekday Truck Trips by Entry/Exit Point - 1976
4.4-4	Percent Distribution of Employment by Industry, South Boston and Boston, 1980-1981
4.4-5	Location of Place of Work for South Boston's Employed Work Force, 1980

LIST OF TABLES (Cont)

Table	Title
4.4-6	Percent Distribution of Occupations of South Boston's Employed Workers, 1970 and 1980
4.4-7	Percent Distribution of South Boston's Population by Largest Source of Income, 1979
4.4-8	Percent Distribution of South Boston's Population by Income Level, 1979
4.4-9	Length of Residence in Current Dwelling Unit, 1980
5.2-1	Monthly Precipitation Extremes for Boston 1941-1980
5.2-2	Monthly and Seasonal Climatic Summary of Boston, Massachusetts
5.2-3	Annual Occurrences of Wind Persistence Episodes
5.2-4	Winter Occurrences of Wind Persistence Episodes
5.2-5	Spring Occurrences of Wind Persistence Episodes
5.2-6	Summer Occurrences of Wind Persistence Episodes
5.2-7	Fall Occurrences of Wind Persistence Episodes
5.2-8	Seasonal and Annual Average Wind Speed (mph) Per Wind Direction at Logan Airport (1970-1981)
5.3-1	Massachusetts and National Ambient Air Quality Standards
5.3-2	Ambient Air Quality Monitoring Stations
5.3-3	Attainment Status Designations of AQCR 119 within 12.4 Miles of New Boston Station
5.3-4	Ambient Air Quality Data Summary for Total Suspended Particulate
5.3-5	Ambient Air Quality Data Summary for Sulfur Dioxide
5.3-6	Ambient Air Quality Data Summary for Nitrogen Dioxide
5.3-7	Ambient Air Quality Data Summary for Carbon Monoxide
5.3-8	Ambient Air Quality Data Summary for Ozone
5.3-9	Ambient Air Quality Data Summary for Lead

LIST OF TABLES (Cont)

Table	Title
5.3-10	Annual Fuel Usage and Estimated Annual Emissions of SO_2, PM, NOx from New Boston Station for the Period 1973-1982
5.3-11	Typical Monthly Fuel Usage and Estimated Emissions of SO_2, PM, and NOx
5.3-12	Major Sources of Particulates, SO_2, and NOx within 12.4 Miles of New Boston Station
5.3-13	Ambient Air Quality Data Summary for Sulfates
5.3-14	Ambient Air Quality Data Summary for Trace Elements
5.3-15	Ambient Air Quality Data Summary for Particulate Gross Alpha and Gross Beta Radioactivity and Thorium-228
5.3-16	Estimated Annual Emissions of Trace Metals and Radionuclides for the Period 1973-1982
5.4-1	Summary of Flood Elevations
5.4-2	Massachusetts Water Quality Standards (1978)
5.4-3	Surface Water Quality Parameters Selected for Review
5.4-4	Water Quality Survey Data for Boston Harbor near New Boston Station
5.5-1	Groundwater Quality at the New Boston Site
5.6-1	Species List of Invertebrates Observed in Screenwell Monitoring at New Boston Station between June 1975 and August 1976
5.6-2	Species List of Fish Observed in NPDES Screenwell Monitoring at New Boston Station between June 1975 and August 1976
5.7-1	Sound Level Survey Locations
5.7-2	Sound Level Survey Instrumentation
5.7-3	Survey of Day and Night Noise Levels
6.2-1	Postconversion Period Wastewater Volumes, Flows, and Design Worst-Case Qualities

LIST OF TABLES (Cont)

Table	Title
6.2-2	Maximum Concentrations for Pollutants in the New Boston Station's Postconversion Wastewater Treatment System Effluent
7.1-1	Summary of Emission Rates of Criteria Pollutants
7.1-2	Oil and Coal Fly Ash Particle Size Distribution
7.1-3	Coal Storage and Handling System Fugitive Dust Emissions
7.1-4	Trace Element Concentrations in Coal, Mass Percentage in Flue Gas, and Collection Efficiency by ESP
7.1-5	Trace Element Concentrations in Residual Oil and Emission Factors
7.1-6	Estimated Trace Element Emission Rates
7.1-7	Radionuclide Emission Factors and Estimated Emissions
7.1-8	Organic Emission Factors and Estimated Emissions
7.1-9	Chimney and Flue Gas Parameters and SO_2 Emission Rates for Existing Oil Firing and Proposed Coal Firing at New Boston and Mystic Stations
7.1-10	Highest 24-Hour Average SO_2 Concentrations Predicted in the Primary PSD Baseline Area (1.5 Percent Sulfur Content Coal)
7.1-11	Highest 24-Hour Average SO_2 Concentrations Predicted Outside the Primary PSD Baseline Area (1.5 Percent Sulfur Content Coal)
7.1-12	Highest Annual Average SO_2 Concentrations Predicted in the Primary PSD Baseline Area
7.1-13	Highest Predicted SO_2 Increment Consumption Associated with Proposed Coal Conversion (ug/m^3)
7.1–14	Combined Net Change in Ambient 1–Hour NO_2 Concentrations (ug/m^3)
7.1–15	Summary of Ambient Impact Analysis of Trace Elements
7.1–16	Ambient Radionuclide Concentration from New Boston and Mystic Stations (pCi/m^3)

LIST OF TABLES (Cont)

Table	Title
7.1-17	Summary of Ambient Impact Analysis of Organics
7.1-18	SO_2 Emissions (tons/year)
7.3-1	Existing New Boston Station Wastewater Treatment System Effluent Qualities and Worst-Case Mass Loading
7.3-2	Postconversion New Boston Station Wastewater Treatment System Anticipated Effluent Limits and Worst-Case Mass Loading
7.4-1	Level of Service (LOS) Criteria for Signalized Intersections
7.5-1	Major Capital Investment Developments in South Boston
7.6-1	Visually Sensitive Areas within 2-Mile Viewshed of New Boston Station
8.1-1	Grain Size Analysis of Reserved Channel Sediment
8.1-2	Bulk Sediment Chemical Analysis of Reserved Channel Sediments in Proposed Dredge Area New Boston Station Coal Conversion - Boston Edison Company
8.1-3	Bioassay and Bioaccumulation Test Results for Reserved Channel Sediment
8.2-1	Coal Conversion Ash Disposal Parameters
8.2-2	Summary of Moisture, Ash, Sulfur, and Heat Content of Coal from Some Major Coal-Producing Seams in the Eastern United States
8.2-3	Estimated Impact of Ash Transport Trucks on Average Daily Traffic in 1987
8.2-4	Summary of Fly Ash Reuse Potential
8.2-5	Summary of Bottom Ash Reuse Potential
10.3-1	Death Rates by Neighborhoods and Cause 1979-1980
10.4-1	Comparison of Trace Element Concentrations in ng/m^3
11.1-1	Capacity Ridership, Bus Routes No. 7, 9, 10, and 11
11.2-1	Boston Zoning District Noise Standards

LIST OF TABLES (Cont)

Table	Title
12.2-1	Specifications of SO_2 Equivalent Method

LIST OF FIGURES

Figure	Title
3.1-1	Waste Stream Outfall Locations
3.1-2	Proposed Chimney Location with respect to Logan Airport
4.1-1	Vicinity Map
4.2-1	Map of South Boston
4.2-2	Landfill History of South Boston
4.3-1	Population Distribution of South Boston
4.3-2	Sensitive Receptors in South Boston
4.4-1	The Regional Road Network
4.4-2	Access Points to South Boston
4.4-3	Existing Designated Truck Routes
4.4-4	Traffic Demand Volume: September 23, 1980
4.4-5	Average Weekday Traffic Volumes without Trucks (1979)
4.4-6	Average Weekday Truck Volumes along Designated Truck Routes (1979)
4.7-1	Plot Plan - Existing Station
4.7-2	Existing MBTA Property
4.7-3	Existing Plot Plan, K Street Property
4.7-4	Existing Wastewater Treatment Flow Chart
4.7-5	Territory Served by Boston Edison Company
5.1-1	General Movement of Air Masses which Frequently Affect New England
5.1-2	Typical Tracks of Low-Pressure Systems Affecting New England
5.2-1	Annual Precipitation at Boston (1941-1980)
5.2-2	Annual Frequency Distribution (Percentage Occurrence) of Wind Direction for Boston, Massachusetts (1970-1981)

LIST OF FIGURES (Cont)

Figure	Title
5.2-3	Winter Frequency Distribution (Percentage Occurrence) of Wind Direction for Boston, Massachusetts (1970-1981)
5.2-4	Spring Frequency Distribution (Percentage Occurrence) of Wind Direction for Boston, Massachusetts (1970-1981)
5.2-5	Summer Frequency Distribution (Percentage Occurrence) of Wind Direction for Boston, Massachusetts (1970-1981)
5.2-6	Fall Frequency Distribution (Percentage Occurrence) of Wind Direction for Boston, Massachusetts (1970-1981)
5.3-1	Location of Ambient Air Quality Monitoring Stations Within 12.4 Miles (20km) of New Boston Station
5.3-2	Areas of Non-attainment of Standards within 12.4 Miles (20km) of New Boston Station
5.3-3	Location of Major Sources of Particulates, SO_2, and/or NOx within 12.4 Miles (20km) of New Boston Station
5.4-1	Reserved Channel Depths, in Feet Below Mean Low Water
5.4-2	100-Year Flood Plain Near New Boston Station
5.4-3	Boston Harbor Location of Water Sampling Stations
5.4-4	Temperature Distribution with Depth at Sampling Station 6 During 4 Days in July and August 1982
5.5-1	Existing Groundwater Monitoring Well Locations
5.7-1	Sound Level Survey Measurement Locations
5.7-2	Statistical Time History of L90, L50, and L10 Levels at Loc. NBS-1 (Hourly Averages)
5.7-3	Range of Nighttime Octave Band Residual Sound Pressure Levels at Position 1 (Zone: Residential/Industrial)
5.7-4	Range of Nighttime Octave Band Residual Sound Pressure Levels at Position 2 (Zone: Residential)
5.7-5	Range of Nighttime Octave Band Residual Sound Pressure Levels at Position 3 (Zone: Residential/Industrial)

LIST OF FIGURES (Cont)

Figure	Title
5.7-6	Range of Nighttime Octave Band Residual Sound Pressure Levels at Position 4 (Zone: Residential)
5.7-7	Range of Nighttime Octave Band Residual Sound Pressure Levels at Position 5 (Zone: Residential)
5.7-8	Range of Nighttime Octave Band Residual Sound Pressure Levels at Position 6 (Zone: Residential)
5.7-9	Range of Nighttime Octave Band Residual Sound Pressure Levels at Position 7 (Zone: Residential)
5.7-10	Range of Nighttime Octave Band Residual Sound Pressure Levels at Position 8 (Zone: Residential)
5.7-11	Range of Nighttime Octave Band Residual Sound Pressure Levels at Position 9 (Zone: Industrial - Anytime)
5.7-12	Range of Nighttime Octave Band Residual Sound Pressure Levels at Position 10 (Zone: Industrial - Anytime)
5.7-13	Range of Nighttime Octave Band Residual Sound Pressure Levels at Position 11 (Zone: Industrial - Anytime)
6.2-1	Proposed Plot Plan Station Area
6.2-2	Proposed Plot Plan Reserve Coal Storage Area (MBTA Property)
6.2-3	Proposed Plot Plan, Construction Laydown and Parking, East First and K Street Property
6.2-4	Air and Flue Gas Flow Diagram
6.2-5	Flow Diagram, Fly Ash Handling System
6.2-6	Flow Diagram, Bottom Ash Handling System
6.2-7	Coal Handling Flow Diagram
6.2-8	Postconversion Wastewater Treatment Flow Chart
6.4-1	Schedule for Preliminary Engineering & Environment Licensing Activities
6.4-2	Schedule for Engineering & Construction

LIST OF FIGURES (Cont)

Figure	Title
7.3-1	Extent of Dredging for Waterfront Facilities
7.3-2	Elevation View of Dredging Sections 1-1, 2-2
7.3-3	Elevation View of Dredging Section 3-3
7.3-4	100-Year Flood Plain Proposed MBTA Property Plot Plan
7.5-1	Proposed and Ongoing Projects in South Boston
7.6-1	Aerial Perspective of New Boston Existing Facility
7.6-2	Visually Sensitive Photograph Locations
7.6-3	Visual Assessment, New England Aquarium Wharf, Photograph Location 1
7.6-4	Visual Assessment, Southeast Expressway, Photograph Location 2
7.6-5	Visual Assessment, Columbus Park, Photograph Location 3
7.6-6	Visual Assessment, John F. Kennedy Presidential Library, Photographic Location 4
7.6-7	Visual Assessment, Castle Island, Photograph Location 5
7.6-8	Visual Assessment, Farragut Road, Photograph Location 6
7.6-9	Visual Assessment, Telegraph Hill, Photograph Location 7
7.6-10	Visual Assessment, Proposed Aesthetic Improvements, East Broadway and L Street, Photograph Location 8
7.6-11	Visual Assessment, Proposed Aesthetic Improvements, Christopher Lee Playground, Photograph Location 9
8.1-1	Location of Test Sediment Collections
8.2-1	Designated Truck Routes
8.2-2	Estimated 1987 11-Hour Traffic Volumes
8.2-3	Estimated 1987 Peak Hour Traffic Volumes
8.2-4	Recommended Routes for Ash Transport Trucks in 1987

LIST OF FIGURES (Cont)

Figure	Title
9.1-1	Historical Price of BECO Fuel Oil
10.3-1	Respiratory Cancer - South Boston (1974-1980)
10.3-2	Pneumonia and Influenza - South Boston (1974-1980)
11.1-1	Public Transportation for South Boston
11.2-1	Proposed Landscape Plan

APPENDIX A

BOSTON EDISON COMPANY
NEW BOSTON STATION
DRAFT ENVIRONMENTAL IMPACT REPORT

Prepared by
Boston Edison Company

EA1/D2

PAST AND PRESENT BASELINE ENVIRONMENTAL ISSUES

L STREET/NEW BOSTON STATION

Prepared by:
Boston Edison Company
May 1983

TABLE OF CONTENTS

A.1 Introduction

A.2 Past and Present Baseline Environmental Issues

  A.2.1 Past Environmental Issues

    A.2.1.1 Air

    A.2.1.2 Noise

  A.2.2 Present Environmental Issues

    A.2.2.1 Particle Fallout

    A.2.2.2 Noise

A.3 Community Involvement/Response Measures

A.4 Conclusions

A.5 Tables A-1 to A-4

A.6 Figures A-1 to A-12

A.7 Attachment: Special Senate Committee Report on "Black Friday", May 13, 1960

NEW BOSTON EIR: APPENDIX A

A.1 Introduction

The Massachusetts Executive Office of Environmental Affairs (EOEA) in its scope of work for the New Boston Station coal conversion Environmental Impact Report (EIR) has required Boston Edison Company (BECo.) to address existing environmental issues attributed to the facility.

While BECo. has always endeavored to operate its facilities in an environmentally responsible manner, at the public meeting held on November 22, 1982 residents of the community surrounding the power plant voiced concerns about excessive noise and dust fallout generated from the New Boston Station facilities. Many of these concerns dated back to the period before New Boston Station became operational and as far back as when the L Street facility operated on coal, while others were relevent to more recent New Boston Station operations.

This report will address both past and present issues as expressed by the community. The report will include discussions of the probable causes of these issues and the corrective measures taken to alleviate them. It will focus in detail on recent noise and fallout studies conducted at the site, listing conclusions, and courses of remedial action, both planned and already implemented.

The report will also describe the steps BECo. has taken to ensure prompt and satisfactory response to the community.

A.2 Past and Present Baseline Environmental Issues

A.2.1 Past Environmental Issues

The L Street/New Boston Station is a large, complex industrial facility located in close proximity to a residential community. BECo.'s operation of this station has occasionally given rise to environmental concerns, but remedial measures were always taken in an attempt to correct these situations. The major areas of community concern have been fugitive dust, stack fallout and noise. The problems arising from these concerns were generally the result of equipment malfunctions such as the loss of a fan or a boiler tube failure.

L Street/New Boston Station is located in what has always been a heavily industrialized section of South Boston; therefore, all of the community's air and noise pollution can not be attributed to Boston Edison operations. Other sources of pollution were/are the MBTA power station, ships in the Reserved Channel, truck traffic, Texaco, (White Fuel), the Navy Annex power plant, the Army Base power plant, and other light industry.

For example, with regard to the so-called "Black Friday" incident of May 13, 1960 referred to at the public scoping meeting of November 22, 1982, BECo. was exonerted by the Senate special Committee investigation of July 1960 (See Attachment). The report issued by the Committee concluded that the incident was caused by the MBTA (then MTA) power plant and "nothing unusual occurred at the Boston Edison plant at L and East First Streets, South Boston,..."

A.2.1.1 Air

From their construction in 1939-42 until 1963, boilers 74, 75 and 76 at L Street Station were fueled by coal. In accordance with accepted industrial and environmental practices for the time, coal was stored in open piles and coal delivery and handling systems were also open to the atmosphere. This resulted in the emission of fugutive dust to the surrounding neighborhood. Also, even though the boilers operated with precipitators consistent with the technology of the period, complaints of fallout were received from the neighborhood. Contributing also to the dust and fallout problems was the use of coal as the primary home heating fuel at this time.

It is important to note that since the 1950's precipitator technology and efficiency have been dramatically improved, and extensive dust control measures have now been developed for improved coal handling. The proposed coal conversion will utilize the best available control technology for particulate and fugitive dust emissions and with this new state-of-the-art technology will be in compliance with all federal, state and local environmental regulations.

The fugitive dust problems were drastically reduced in 1963 when L Street Station stopped burning coal. They were totally eliminated in the early 1970's when the remaining coal handling equipment and coal piles were removed from the site. From 1963 until the station ceased active operation in 1981, the L Street boilers burned No. 6 fuel oil. However, because of the age of the boilers, the fallout problem was not completely eliminated until these boilers ceased active operation.

In 1965 and 1967 Units #1 and #2 at New Boston Station came on line, respectively. The source of fuel for these units has always been No. 6 residual fuel oil, even though they were also designed to burn coal. These units were constructed in full compliance with all the environmental regulations in effect at that time. After the enactment of new regulations by Federal and State agencies in the 1970's, the station continued to meet by a wide margin all particulate limitations imposed on existing units.

To ensure optimum boiler combusion performance and efficiency, operating and maintenance procedures were written and implemented at the time the boilers were installed. These procedures listed parameters and equipment associated with combusion performance to be monitored and maintained on a regular basis. Through the institution of these procedures particulate emissions were kept to a minimum. However, on February 8, 1977, the air branch of the Environmental Protection Agency (EPA) issued an order that the Company cease and desist from violating state regulations limiting visible smoke emissions at BECo. generating stations. Although the primary focus of the order was visible emissions from Mystic Station boilers, revised operating and maintenance procedures to ensure continuous control of visible emissions were required for both Mystic and New Boston stations.

Although the Company always had equipment, such as opacity monitors and TV cameras, to monitor visible emissions from all boilers the Order required the Company to upgrade these monitors to meet stricter current performance specifications. These monitors were installed and tested at Mystic and L Street/New Boston in accordance with federal standards shortly after the issuance of the order. The order further required the submittal of quarterly opacity reports to the EPA and the Department of Environmental Quality Engineering (DEQE). With the institution of the revised and updated combustion operation and maintenance procedures and the installation of continuous opacity monitors, the Company significantly reduced visible emissions. Through the quarterly reports, visual observations, plant inspections and annual compliance tests, the DEQE and EPA have been kept informed of visible emissions at L Street/New Boston Station.

Although reduced, visible emissions continued to be a sporadic problem from New Boston Units #1 and #2 because of weather related difficulties involving the boiler tube cleaning system. Tube cleaning, commonly referred to as soot blowing, is a means of cleaning the boiler fireside tube surfaces. It is accomplished by using a retractable steam lance which travels in and out of selected sections of the boiler. Tube cleaning is required to prevent boiler tube failures and to ensure satisfactory heat transfer.

Severe weather conditions to which the steam lances were exposed over the years rendered many of them inoperable and others in need of constant maintenance. To correct this, new steam lances designed to withstand exposure to the elements were installed in 1979 at a cost of $1,500,000.

Once the new steam lances were installed, a consultant was hired to optimize boiler combustion and to determine the optimal tube cleaning frequency and sequence. As a result of the study, various changes to the tube cleaning operation were instituted and a further reduction in opacity was realized. The air quality branch of DEQE was involved throughout the testing program and monitored the results through field inspections and our quarterly opacity reports. The Company's opacity reports since the completion of the study in early 1980 clearly demonstrates a significant improvement in visible emissions from the units at New Boston Station. In addition, Company records show that only one(1) or two(2) claims per year have been made against the Company for soot emission damage.

A.2.1.2 Noise

In the past there have been complaints of intermittent noise emanating from the L Street/New Boston facility. One of the major causes of concern was the loudspeakers associated with the page system. Once aware of this problem, the Company promptly eliminated the noise source by removing certain loudspeakers, redirecting others and limiting the use of outdoor speakers between the hours of 7:00 p.m. and 7:00 a.m.

In 1981 significant reductions in ambient noise levels were realized. When the L Street boilers ceased operations, major sources of noise were eliminated which included forced draft fans and induced draft fans which were located on open, upper levels of the station. Other sources were deaerator vents, and loud speakers.

Until the recent public scoping meeting, the Company was unaware that noise associated with the current routine operation of New Boston was a major concern in the community, since we had not received complaints about routine operations from the community. In addition noise problems from routine operations cannot be detected from inside the plant but require offsite investigation. As a result of complaints received at the meeting the Company conducted recent investigations and identified occasional noise sources including, deaerator vents, steam lance packing leaks, steam lance pressure reducing valve station, open doors and hatches, vent fans and various boiler safety valves. Much of the noise associated with these sources has been reduced or eliminated and other longer term solutions are currently being studied. A detailed discussion of current noise sources and proposed remedial action is found in Section A.2.2.2 of this report.

BECo. acknowledges that there have been environmental concerns associated with the operation of L Street/New Boston Station in the past, particularly early L Street coal operations. Through the years as a result of operational changes, the implementation of various corrective measures and the advent of environmental regulation most of these problems were thought to have been resolved or substantially mitigated.

As has been the Company practice in the past, now that we are aware of the concerns of the community corrective action will be taken. Section A.2.2 immediately following will detail the Company's most recent efforts to eliminate fallout and noise concerns and the mitigative measures which have already been implemented along with those planned for the future.

A.2.2 Present Environmental Concerns

In view of concerns expressed at the November 22, 1982 public meeting and subsequent meetings held with community representatives, it appears that the predominant community concerns associated with current station operations are particle fallout and noise.

This section deals with these issues individually and in detail. Various studies were conducted to quantify these conditions particularly as they relate to New Boston Station's operation. These studies are described along with the results and recommendations of the studies.

The corrective measures taken or planned for implementation and any follow-up studies are also described.

A.2.2.1 Particle Fallout

A.2.2.1.1 Background

In terms of air quality the predominant issue of public concern appears by far to be that of particle fallout on the neighborhood surrounding the station.

Fallout material can be defined as particulate matter which is occasionally emitted by any combustion process (e.g., industrial and home heating boilers, wood stoves, etc.) and is large enough to settle from the plume by gravity close to the source of the emissions.

Typically the plume from a power plant, including particulate, rises into the atmosphere, is carried, dispersed, and diluted by the wind, and has no contact with the ground for several miles downwind of the stack. Thus, for the most part, the New Boston Station plume would have no measurable contact with the community of South Boston.

Depending upon the size of the particulate emitted some of it can travel long distances with the plume, while some can fall out within a short distance from the source. Particulate smaller than about 10 microns (1 micron = 0.00004 inches) in diameter settles out slowly and remains in the plume until it is several miles downwind from the plant. However, particulate in the 30 to 50 micron (and larger) range will tend settle out within a limited distance of the plant under a variety of weather conditions. These larger particles also correspond to material which can be visually detected as individual pieces of fallout, or possibly as an observable dust layer on a clean surface.

The material emitted by a power plant that may subsequently fall out on the surrounding community fits into two general categories:

a) Combustion generated dust (soot) which can be visually detected as individual pieces of fallout.

b) Scale from surfaces exposed to moving flue gas which can include flakes of material an inch or more in diameter.

In the first category, the generating mechanism is incomplete combustion usually caused by insufficient excess air and/or inadequate fuel atomization.

The second type can include material from all types of surfaces in the boiler such as water and steam containing tubes, air heaters, flue gas duct walls, etc. A number of mechanisms can lead to the formation and release of this scale. Frequently, corrosion processes contribute to this type of fallout material.

A.2.2.1.2 Fallout Assessment Program

Particulate emission measurements of the New Boston boilers conducted in compliance with state requirements have always been well under the allowable regulatory limits. The Massachusetts particulate emissions standard for the New Boston boilers is 0.12 lbs. of particulate per million BTUs of boiler heat input (lbs/10^6 BTU) and the results of tests on these boilers ranged from 0.03 to 0.04 lbs/10^6 BTU, or only approximately 30% of the allowable emission standard.

In order to determine if the boilers could indeed pass regulatory emission tests by such a wide margin and yet still be emitting fallout, BECo. sought the advice of an environmental consulting and engineering firm nationally recognized in emission testing and combustion processes, KVB of New York and California. KVB informed BECo. that it is possible for fallout size particulate to occur in a boiler which passes the EPA test. This particulate matter is at least an order of magnitude greater in size than that usually measured during the EPA mandated particulate test procedure and is rarely observed on EPA particulate filters. The testing method is designed to capture particulate matter primarily in the 1 to 30 micron size range. The EPA filtered particulate matter can include fallout particulate, but these larger particles are usually too few and far between to be caught in the typical EPA test.

KVB recommended an initial diagnostic program designed to determine the general characteristics of any fallout material being emitted. This program included the following:

a) Determination of the approximate current amounts of emitted materials so that the effect of any changes may be compared to an original baseline.

b) Determination of the general chemical or elemental composition to help identify potential formation mechanisms in the boiler.

c) Determination of 24 hour emission patterns to help associate emission patterns with specific plant operational activities such as boiler tube cleaning or load changes and thus, identify potential formation mechanisms.

d) Measurements of flue gas sulfur trioxide (SO_3) along with flue gas temperature to provide an initial indication of the potential influence of corrosion processes.

KVB was retained to perform the fallout assessment, and testing began on the New Boston Station boilers during the first week in February, 1983. The actual fallout emission evaluation activities consisted of two weeks of on-site testing followed by a period of data analysis and specific laboratory analyses. Testing activities consisted of the following:

1) Large particle (i.e., particles with sufficient size to be potential fallout material) emission trends were obtained from the exit of the air heaters, at the same location that the EPA tests were performed. This system used a high volume (200 cubic feet of flue gas per minute sample flow) sampler that deposited particles on a collection plate rotated at one revolution per day, to determine 24 hour emission patterns.

2) Discrete particles were removed from the sample plates for analysis with a scanning electron microscope. This technique determines relative amounts of the elements, but not a total percentage.

3) Some ambient samples were collected after a boiler upset occurred in which fallout material was discovered on ground level surfaces. A few of these samples were also subjected to analysis with the scanning electron microscope.

4) Bulk samples of particulate deposited on certain sample disks in large quantities were analyzed for sulfuric acid content.

5) A limited assessment of the SO_3 levels present in the flue gas was performed using a controlled condensation method.

6) Carbon monoxide and oxygen measurements were taken at selected times during the testing to characterize the combustion condition of each boiler.

7) A representative sample of fuel oil was obtained for analysis. This analysis serves as an aid in interpreting the data on emitted particle chemistry.

8) Two fuel gun nozzle assemblies (tips) were returned to KVB's facilities for flow calibration. One tip was new and the other had been in service for several months. This allowed a direct comparison of flowrate and atomization between new and used burner hardware.

A.2.2.1.3 Results of the Program

The results of the fallout assessment program described above can be summarized as follows:

1) Fallout size particulate matter is being emitted from both New Boston Station boilers.

2) This particulate matter includes both combustion generated dust and surface generated scale or agglomerates.

3) The particulate which appears in the greater quantity is a fine dust directly related to the combustion performance of the boilers.

4) The contribution of any surface generated particulate to the problem cannot be determined until the combustion problems are solved.

The boiler combustion problem referred to above appears to be the result of, in part, changing fuel characteristics and local fuel/air maldistributions between burners as well as poor atomization at low loads due to low burner pressures. The fuel/air maldistribution could be the result of the following factors:

1) Uneven fuel nozzle tip wear which was seen in a visual examination of the hardware and was confirmed by laboratory flow tests.

2) Uneven fuel oil pressure at different burner levels.

Another factor which may be contributing to the combustion problem is the maintenance of low oxygen levels in the boiler. This mode of operation minimizes the formation of acid in the boiler and optimizes boiler efficiency, but may result in operation near the point of incomplete combustion due to insufficient excess air.

A.2.2.1.4 Corrective Measures

Adequate control of furnace combustion conditions will eliminate fallout carbon and should reduce or at least maintain the present levels of sulfur trioxide. Based upon KVB's recommendation in addition to our normal quality control procedures BECo. proceeded with a combustion performance assessment of the fuel nozzles and the furnace as a whole.

This combustion performance assessment involved two related programs:

1) Assessment of fuel nozzle maintenance requirements: A complete set (24 tips) of nozzle assemblies plus four spares was sent to KVB for inspection and flow calibration. The calibrated tips were installed in one of the units and at two week intervals four of these nozzles at a time will be removed and sent to KVB for recalibration. This procedure should establish a nozzle wear pattern and provide a basis for maintenance decisions about replacement of the nozzles and provide a quality control program.

2) Combustion optimization program: The specific objectives of this program include:

    a) Measurement of fuel/air ratio uniformity across the furnace and determination of the cause of any significant variations.

    b) Determination of actual minimum excess air requirements.

    c) Assessment of monitoring requirements which are adequate to continuously track unit combustion performance.

    d) Determination of the approximate relationship between excess air and fuel pressure which must be observed at low boiler loads in order to assure the burn up of combustion dust which tends to form when either excess air or fuel pressure is too low.

The fuel nozzle wear assessment program has already been initiated. The combustion diagnostic program began the week of April 25, 1983.

Once the combustion problem is resolved, an assessment of the extent to which flakes of scale and other surface formed deposits are causing fallout problems will be carried out. This will ensure that all potential fallout generation mechanisms are thoroughly investigated.

The results of the corrective measures mentioned above are not available at this time in the EIR process. Once the results of the described efforts are available, a supplement to this report will be prepared and circulated in the community.

The final results of the studies will be incorporated in the design of the new combustion system for both coal and oil firing, should we proceed with the coal conversion project, to insure complete mitigation of particle fallout. In addition, new precipitators would be installed during the proposed conversion which would remove the larger particulate matter along with more than 99% of the flyash in the combustion gases leaving the boiler.

A.2.2.2 Noise

The other major area of concern expressed by the community at the public scoping meeting was that of noise. This section will detail the results of the ambient noise survey conducted in the community for purposes of the EIR, the corrective actions taken to mitigate station generated noise, the results of the follow-up community noise survey, and future plans for further noise reduction.

Overall sound is composed of many frequencies at varying sound levels. To describe overall sound in a simple term, it is expressed in "A weighted" decibels (dB(A)). The dB(A) level combines the sound levels at all the different frequencies using "A weighing", which simulates sound as perceived by the human ear and expresses it as one number.

Sound is also expressed in terms of octave band sound levels. For the purposes of this report the sound frequency spectrum is divided into nine (9) octave bands ranging from 31.5 cycles/sec (Hz) to 8000 Hz.

The sound level data was analyzed in light of regulations for the control of noise in the City of Boston.

The City of Boston regulations 3.2 through 3.5 mandate the maximum sound levels, both in dB(A) and in octave bands which shall not be exceeded in various zones such as residential (50dBA), residential/industrial (55dBA), business (65dBA), and industrial (70dBA) as defined in and established by the Boston Zoning Code. See attached Table A-2 for details.

Results of the latest survey of sound levels in the community conducted during March and April 1983 show that the noise contributions from the station are in compliance with the overall dB(A) limits prescribed in the city of Boston noise regulations at all but one location where the exceedance is only 1 dB(A). A one(1) dB(A) difference in sound pressure can barely be perceived by the human ear.

Octave band analysis of the sound level survey results indicates that despite compliance with the overall dB(A) limits sound levels attributable to New Boston Station operation exceed the City of Boston octave band noise limits at four (4) out of the eight (8) locations surveyed in the residential community. BECo. is currently working to identify the sources of these exceedances and will investigate potential measures to eliminate them.

In addition to noise generated by routine station operations, there are other sources (e.g., safety valves) of intermittent noise which can be an annoyance to the community. BECo. has identified these sources and has conducted a study to determine potential noise abatement measures. BECo. is evaluating the results of the study and will develop a course of action.

A.2.2.2.1 Results of Sound Level Surveys in the Community

The first sound level survey was conducted in the community during the period of November 1 through November 4 and on November 18, 1982. The sound level survey was conducted at 11 positions in the vicinity of New Boston Station as described and shown in Table #A-1 and Figure #A-1 using instrumentation listed in Table A-3.

The results of this survey are graphically illustrated in Figure #A-2 through A-12.

The sound level surveys were conducted late at night when other intruding noises such as traffic, aircraft, etc. were a minimum. Analysis of the sound level survey indicated the following:

1) At Position #1 (residential/industrial zone) sound levels were below 55 dB(A) as required by the Boston Noise Regulations. The octave band analysis indicated however that sound levels in the 1,000 Hz and 2,000 Hz octave bands occasionally exceeded the code by 1 to 3 dB. See Figure #A-2 for details.

2) At Position #2 (residential zone) sound levels were about 46-51 dB(A) compared to the 50 dB(A) allowed by the city. The octave band analysis indicated that the sound levels in the 500, 1,000, 2,000, and 4,000 Hz octave bands were above the limit allowed by the city. See Figure #A-3 for details.

3) Position #3 is located in industrial/residential zone. Sound levels measured were about 54-56 dB(A) compared to 55 dB(A) allowed by the city regulations. Octave band analysis showed that sound levels exceed the regulations in the 1,000, 2,000 and 4,000 Hz octave bands. See Figure #A-4 for details.

4) Position #4 is located in the residential zone. Sound levels measured were about 41-45 dB(A) compared to the 50 dB(A) limit in the city regulations. Due to shielding provided by existing building structures, the sound levels were not high. See Figure #A-5 for details.

5) Position #5 is located in a residential zone. Sound levels were about 1 to 3 dB(A) above the code limit of 50 dB(A). Octave band data indicated that the violations were in high frequency octave bands. See Figure #A-6 for details.

6) Position #6 is located in a residential zone. Results were similar to Position #5. See Figure #A-7 for details.

7) Position #7 is located in a residential zone. Sound levels were about 47-51 dB(A) compared to 50 dB(A) allowed by the city regulations. Again, the octave band data indicated that the sound levels were in excess of the city limits in 500, 1,000, 2,000 and 4,000 Hz octave bands. See Figure #A-8 for details.

8) Position #8 is located in a residential zone. Results were similar to but slightly lower than Position #7 as described above. See Figure #A-9 for details.

9) Position #9, 10 and 11 are within an industrial zone. Sound levels were below the limits prescribed in the city regulations at Position #9 and 10. At Position #11 sound levels were exceeded in the all octave bands between 125 Hz to 8,000 Hz. See Figures #A-10, A-11 and A-12 for details.

The actual readings taken during this survey can be found in Table A-4.

A.2.2.2.2 Identification of Noise Sources

Results of the survey as discussed in the previous section indicated that noise control measures should be implemented as soon as possible to reduce the plant noise contributions to the surrounding community. Sound level surveys were conducted on the plant site to determine possible noise sources in order to treat them.

It is a difficult task to isolate the noise sources due to the fact that when the plant is operating all major noise sources such as fans, compressors, pumps, etc., have to run at the same time and can not be taken out of service to determine the noise contribution of each individual source.

The preliminary survey conducted on the site indicated that the high frequency sound in the community could be attributed to:

- Routine Operational Sources

  1) Deaerator vent on Unit #1 and 2

  2) Tube cleaning steam lance pressure reducing valves

  3) Steam leaks in the steam lance piping system

4) Open kinear doors near Summer Street

5) Open louvers on west wall facing Summer Street

6) Forced draft fans

7) Main and hot reheat steam lines

8) Tube cleaning steam lances

- Intermittent source contributions

9) Various Safety valves

A.2.2.2.3 Corrective Actions Implemented Between Period of December, 1982 and April 5, 1983

- Routine Operational Sources

1) Silencers for the deaerator vents were ordered in December of 1982. The silencers were installed by March 7 at a cost of $45,000 to reduce the noise levels by more than 25 dB(A). With the installation of these new silencers, the vent noise now is not audible at any of the survey positions.

2) The steam lance pressure reducing valves were generating near field sound levels of 97 dBA. In early March, 1983, BECo. installed acoustical insulation on the bodies of these valves to reduce the noise levels. The sound levels were sufficiently reduced so that the nearby residential community is not affected by it. This sound control measure cost approximately $2,000.

3) Sixty four steam lance isolation valves were installed at a cost of approximately $40,000 to facilitate isolation of individual steam lances. The ability to isolate steam lances helps in providing quick maintenance and in turn eliminates noise generated by steam leaks in an expeditious manner.

4) With the institution of new administrative procedures the Kinear doors on the Summer Street side of the plant are now kept closed at all times. These Kinear doors when kept in the closed position provide a significant noise reduction especially in higher frequencies.

5) All louvers in the wall facing Summer Street are kept closed at all times under the new administrative procedure to reduce noise reaching the community.

6) Forced draft fan noise levels were measured and analyzed to identify their contribution to the sound levels in the community. At this time it is believed that these four fans do contribute some noise to the ambient. The work required to positively identify/quantify their contribution to the ambient

is very time consuming. BECo. is currently conducting a detailed and thorough investigation into the problem and its associated potential solutions.

7) Acoustical intensity measurements of the main and hot reheat lines were conducted in February, 1983 by Stone and Webster Engineering Corporation (SWEC). Results indicate that the noise generated by the steam lines is not enough to affect the community. No further action was recommended.

8) SWEC has completed a study in connection with the noise from boiler tube cleaning operations. At this time the study indicates that individual blanketing of each steam lance is advisable. BECo. plans to conduct a test program using two (2) steam lances to determine the effectiveness of the proposed solution in the near future.

. Intermittent Sources

Safety Valve Noise

Safety valves are required by various codes and regulation for the safe operation of the generating units. These valves vent excess pressure in order to protect the equipment such as boiler, piping systems, etc., and can be a source of intermittent noise in the community. Stone & Webster has conducted a study to define:

a) the noise contribution to the community due to intermittent operation of safety valves,

b) sound level reduction required to reduce its impact in the community,

c) measures required to mitigate the problem, and

d) capital estimate of the most cost effective measures selected.

BECo. is currently reviewing the results of the study to determine the appropriate course of action.

A.2.2.2.4 Results of Sound Level Survey After Implementation of Corrective Actions

Since the implementation of the corrective measures outlined in Section A.2.2.2.3 additional sound level surveys have been performed to determine the effect of the corrective measures in the community.

Sound level surveys were conducted on March 23, April 1, 1983 and April 7, 1983. Results of these surveys are summarized below, and for purposes of comparison with November 1982 data, the results are also graphically included in Figures A-2 to A-12.

1) Position #1 now meets the Boston noise regulations at all times. Sound pressure levels in all octave bands are reduced by about 5 to 7 dB showing significant improvement. (See Figure #A-2 for details).

2) Position #2 also shows significant reduction in the sound levels in 1,000, 2,000, 4,000 and 8,000 Hz octave bands. Sound levels would have been within the Boston Noise Regulations at all times had it not been for the fact that a steam lance malfunctioned at the time the survey was conducted. Even then, it is only a 1 to 4 dB exceedance in the 1,000, 2,000, and 4,000 octave bands. (See Figure #A-3 for details).

3) At Position #3 sound levels in the community are significantly reduced in all octave bands between 500 Hz and 8,000 Hz. Sound levels are at or below the Boston noise regulations except for 2dB exceedances in the 1,000 and 2,000 octave bands (See Figure A-4 for details).

4) At Position #4 the sound levels are now below the limits prescribed in the Boston noise regulations. (See Figure #A-5 for details).

5) At Position #5 sound levels in 2,000, 4,000 and 8,000 Hz octave bands show improvement, however, the night time regulations are still exceeded by 1-2 dB at 500 Hz, 5-7 dB at 1,000 Hz, 5-8 dB at 2,000 Hz, and 8 dB at 4,000 Hz. (See Figure A-6 for details).

6) Readings at Position #6 show significant improvement in the 2,000, 4,000 and 8,000 Hz octave bands. Violations in 500, 1,000, 2,000 Hz and 4,000 Hz octave bands still exist. (See Figure #A-7 for details).

7) Position #7 results are similar to Position 6. (See Figure #A-8 for details).

8) At Position #8 sound pressure levels exceed the limits prescribed in the Boston noise regulations, at 500, 1,000, and 2,000 Hz. (See Figure #A-9).

9) Position #9, 10 show improvement and the sound levels are within the limits for an industrial zone. (See Figures #A-10, A-11 details).

10) Position #11 also shows improvement, but exceeds the Boston noise regulations by 1 dB in five (5) octave bands (See Figure A-12).

The actual readings taken during this survey can be found in Table A-4.

A.2.2.2.5 Summary

BECo. has made significant efforts to lower the sound levels in the community. When the sound level survey conducted in November of 1982 indicated that the plant contributed noise above the Boston regulations, BECo. committed/expended about $140,000 to mitigate these problems. Routine station noise levels are in compliance with dB(A) requirements at all but one location although some exceedances still exist in the octave band levels at locations 3, 5, 6, 7, in the residential community.

BECo. will continue to investigate means of eliminating the remaining exceedances to ensure that station operation is in compliance with the City of Boston Noise Regulations.

A.3 Community Involvement/Response Measures

Boston Edison Company has made a commitment to assure that issues, problems and concerns raised by the community pertaining to New Boston Station receive prompt attention and response. To achieve this goal, the company established an office for community relations at the Boston Edison Customer Service Center, 428 Broadway.

The Community Relations Manager is the primary representative of Boston Edison Co. to residents of South Boston. As a liaison between company and community, the manager works through established procedures to maintain the flow of communication between the two. The manager is responsible for establishing and maintaining dialogue with community groups, providing information to members of the community and addressing community concerns.

The Community Relations Manager initiates and maintains contact with leaders of various community organizations, keeping the company executives informed of their concerns.

When information is requested by the community on company actions, policies and responses, the manager provides it. He also presents more formal information programs to interested community groups and maintains contacts with the local media. Special mailings are made and meetings are held periodically explaining developments at New Boston Station to South Boston residents. Moreover, the community relations office contains documents relating to the environmental aspects of coal conversion. It is open to the public five days a week.

The Community Relations Manager oversees the complaint response procedure, ensuring that formal complaint forms are logged and forwarded to the Managers of Operations, Community Relations and Environmental Affairs. In the event of a major disturbance the Manager of Operations and the Manager of Community Relations will be notified immediately, day or night. When community or company needs require assistance from other Boston Edison departments, the manager coordinates and expedites the activities. Furthermore, he encourages cooperation from other departments in modifying priorities for the mutual benefit of company and community.

OPERATION DIRECTIVE #3

NEW BOSTON STATION

Effective immediately, any complaints received at the station from the public on any subject will be recorded on the Approval Form. (Attached)

In the event of a major disturbance that generates numerous complaints, the Watch Engineer will notify the person on-call, who in turn will notify the Manager of Operations and the Manager of Community Relations. (South Boston Section)

Copies to: Messrs. J. F. Mazzarella
R. J. Schug
E. G. O'Brien

EKelly

NOTE: ONLY THE WATCH ENGINEER IS TO TALK WITH THE COMPLAINANT

NEW BOSTON STATION

FORMAL COMPLAINT FROM NEIGHBOR

Name of Watch Engineer who talked with the Complainant: ____________________

DATE OF CALL: ____________ TIME CALL RECEIVED: ____________________

NAME OF COMPLAINANT: ____________________________

TELEPHONE: ____________________

ADDRESS: ____________________________________

What the complaint is in detail: ______________________________________

____

____

What information given to the Complainant in detail: ____________________

____

What immediate action taken to correct the condition: ____________________

____

____

Who Notified: ____________________ DATE: ______________ TIME: __________

What action should be taken to correct the problem: ____________________

____

____

ALL INFORMATION TO BE LOGGED IN THE LOG BOOK

cc: Division Head
Manager of Operations
Manager of Community Relations (South Boston)
Manager of Environmental Affairs

A.4 Conclusion

As demonstrated by actions taken and results documented in this report (i.e, fallout reduction program, noise abatement program and complaint response procedures) Boston Edison Company (BECo.) is endeavoring to alleviate existing environmental problems at New Boston Station. It cannot be stated, however, that once these programs are completed that there will never be a noise, fallout or other problem associated with New Boston. There can be unavoidable equipment failures that could result in noise or fallout. However, every effort is being made by BECo. to minimize and immediately resolve such incidents and to insure that day-to-day operations do not create a problem for the surrounding community.

As a matter of executive policy, BECo. has committed itself to being a good neighbor to the communities surrounding all our facilities. This commitment will continue after the proposed coal conversion and plant modernization of New Boston Station, through the community involvement and response measures outlined in Section A.3.

BECo. believes that the coal conversion of New Boston will result in better environmental conditions in the community neighboring the facility.

Included in the plans for coal conversion would be the addition of high efficiency electrostatic precipitators (ESPs) to reduce particulates and eliminate fallout problems. The ESPs use electrical forces to capture particulate matter from the flue gas stream. A well designed and maintained ESP can collect better than 99.% of the particulate in the flue gas.

These factors plus all of the other plans, such as noise and fugitive dust controls, etc., which are detailed in the Environmental Impact Report, will make the coal converted New Boston Station with its modern coal firing and pollution control equipment a better neighbor than it has been in the past.

Section A.5

TABLES A-1 to A-4

TABLE A-1

SOUND LEVEL SURVEY LOCATIONS

Position	Zone	Location
1	Residential/ Industrial	Corner of East First and K Streets
2	Residential	Corner of East Second and K Streets
3	Residential Industrial	Corner of East Second and L Streets
4	Residential	On East Second Street, half-way between L and M Streets
5	Residential	On M Street, half-way between East First and East Second Streets
6	Residential	On East First Street 800 feet east of M Street
7	Residential	Corner of East Second and N Streets
8	Residential	On Broadway, half-way between M and N Streets
9	Industrial	On East First Street, half-way between L and M Street
10	Industrial	Corner of Summer and East First Streets
11	Industrial	On Summer Street, 450 feet north of East First Street

TABLE A-2

Zoning District Noise Standards

Noise standards referred to in these Regulations for the several zoning districts of the City of Boston, as defined in and established pursuant to the Boston Zoning Code, are as established by the following Table.

TABLE OF ZONING DISTRICT NOISE STANDARDS

Maximum Allowable Octave Band Sound Pressure Levels

Octave Band Center Frequency of Measurement (Hz)	Maximum Allowable Octave Band Sound Pressure Levels					
	Residential		Residential Industrial		Business	Industry
	Daytime	All Other Times	Daytime	All Other Times	Anytime	Anytime
31.5	76	68	79	72	79	83
63	75	67	78	71	78	82
125	69	61	73	65	73	77
250	62	52	68	57	68	73
500	56	46	62	51	62	67
1000	50	40	56	45	56	61
2000	45	33	51	39	51	57
4000	40	28	47	34	47	53
8000	38	26	44	32	44	50
Single-Number-Equivalent (dB(A))	60	50	65	55	65	70

APPENDIX A

TABLE A-3

SOUND LEVEL SURVEY INSTRUMENTATION

A. Community Noise Analyzer (CNA) System

Instrument		Serial Number
B&K	Type 4426 Community Noise Analyzer	789622
w/	B&K Type 2312 Alphanumeric Printer	728201
	B&K Type 4165 1/2-inch Microphone	923301
	B&K Type 2619 Cathode Follower	805336
	B&K Type 4230 Calibrator	792543
	B&K 1/2-inch Microphone Windscreen	-

B. External Noise Metrologging System

Instrument		Serial Number
Metrosonics dB-652 Metroreader		1140
Metrosonics dB-301 Metrologger		1902
w/	301-14 PROM	-
	MK-301 R Pendant Microphone	40238
Metrosonics dB-301 Metrologger		1903
w/	301-34 PROM	-
	MK-301 R Pendant Microphone	40239
Metrosonics dB-301 Metrologger		1904
w/	301-14 PROM	-
	MK-301 R Pendant Microphone	40240
Metrosonics dB-301 Metrologger		1905
w/	301-34 PROM	-
	MK-301 R Pendant Microphone	40241
Metrosonics Cl-302 Calibrator		1691

C. Tape Recording System

Instrument		Serial Number
Nagra IV-SJ Tape Recorder		2179
w/	Nagra QJPA Microphone Preamplifier	278
	Nagra QJPA Microphone Preamplifier	476
	B&K Type 4165 1/2-inch Microphone	791257
	B&K Type 4165 1/2-inch Microphone	977346
	B&K Type 4230 Acoustic Calibrator	782537
	B&K 1/2-inch Microphone Windscreen	-

1 of 2

TABLE A- 3 (Cont)

D. Programmable Noise Analyzer (PNA) System

Instrument	Serial Number
B&K Type 2215 Precision Sound Level Meter	788613
B&K Type 2215 Precision Sound Level Meter	788614
w/ B&K 2804 Microphone Power Supply	815266
B&K 4165 1/2-inch Microphone	782543
Hewlett-Packard (HP) 3468A Multimeter	2137A0015
HP 41CV Computer	-
HP 82143A Peripheral Printer	-
HP-IL Interface Loop	-

2 of 2

TABLE A-4

SURVEY OF DAY AND NIGHT NOISE LEVELS

			Sound Pressure Level Data, dB, re 2 x 10^{-5} N/M^2										Statistical Data, L(N) in dBA					
Location	Date	Time	dBA	31.5	63	125	250	500	1K	2K	4K	8K	L90	L50	L10	L01	LEQ	Audible Noise Sources
								Station Property Measurements										
NBS-1	11/01/82	1524	59	61	64	60	56	58	51	51	47	39	60	61	70	76	66	Traffic, Station Noise
								Community Measurements										
1	11/01/82	1555	54	----	-----	too variable to record					----	---	59	65	75	84	72	Traffic, Car/Truck Passbys
1	11/01/82	2550	55	59	58	60	53	47	46	42	33	19	56	57	60	69	59	Traffic, Car/Truck Passbys
1	11/02/82	1529	62	65	70	67	65	63	61	55	52	45	61	68	80	91	78	Truck Traffic, Woodworking Shop
1	11/03/82	0251	47	58	59	53	45	41	41	39	31	23	47	47	48	48	47	Station
1	11/04/82	0233	48	54	55	52	46	43	41	40	34	23	46	47	48	49	47	Quiet, Station
1	11/18/82	0105	48	61	57	56	49	45	42	37	28	13	48	49	58	65	55	Station, Traffic
1	03/23/83	0040	46	57	57	54	48	44	41	37	26	20	--	--	--	--	--	Station, Sootblower Wind
1	04/01/83	0034	45	58	57	53	46	42	42	39	34	16	--	--	--	--	--	Station, Sootblower Whistle & Squeal, Bus
1	04/07/83	0023	48	58	57	54	47	43	42	36	27	13	--	--	--	--	--	Station
1	04/07/83	0309	45	59	56	53	47	41	40	32	23	12	--	--	--	--	--	Station, Distant Traffic
2	11/01/82	1609	53	----	-----	too variable to record					----	---	52	57	66	77	65	Traffic
2	11/01/82	2357	51	55	57	54	52	49	46	45	36	23	52	53	60	62	56	Station, Traffic
2	11/02/82	1533	58	58	61	60	55	55	54	46	39	27	56	61	68	70	63	Commuter Traffic
2	11/03/82	0256	49	54	56	52	47	43	41	41	34	25	48	48	49	50	48	Station
2	11/04/82	0238	46	52	51	48	45	41	40	39	33	22	45	46	46	47	46	Quiet, Station, One Car
2	11/18/82	0113	47	58	57	55	47	43	44	39	30	14	48	48	52	52	50	Station, Traffic
2	03/23/83	0100	44	56	54	50	45	41	38	31	21	14	--	--	--	--	--	Station, Wind

1 of 6

NEW BOSTON STATION - DEIR

TABLE A-4 (Cont)

			Sound Pressure Level Data, dB, re 2 x 10^{-5} N/M²										Statistical Data, L(N) in dBA					
Location	Date	Time	dBA	31.5	63	125	250	500	1K	2K	4K	8K	L90	L50	L10	L01	LEQ	Audible Noise Sources
2	04/01/83	0104	47	56	57	50	44	41	39	37	27	15	--	--	--	--	--	Station
2	04/07/83	0038	45	58	57	52	47	43	42	37	29	13	--	--	--	--	--	Station
2	04/07/83	0317	44	57	58	52	44	41	38	31	21	11	--	--	--	--	--	Station, Some Wind
3	11/01/82	1621	60	---------		too variable to record					-------		60	64	68	78	66	Traffic, Bus, Aircraft
3	11/02/82	0004	56	65	62	58	52	51	50	50	43	30	57	59	63	68	60	Station, Occasional Cars
3	11/03/82	1544	61	62	64	59	56	too variable to record					60	64	71	81	68	Commuter Traffic, Aircraft
3	11/03/82	0301	55	64	67	58	54	50	50	49	42	30	55	56	56	56	56	Station Noise
3	11/04/82	0246	54	58	62	55	52	49	49	48	44	34	54	55	61	67	57	Station, Airplane
3	11/18/82	0121	54	64	64	58	52	49	49	47	39	23	54	54	57	65	56	Station, Occasional Passbys
3	03/23/83	*	52	62	60	56	51	49	46	40	30	23	--	--	--	--	--	Station, Drain, Wind, Bus
3	04/01/83	0121	50	63	64	56	49	47	47	41	33	22	--	--	--	--	--	Station, Car Passbys, Sootblower, Aircraft
3	04/07/83	0049	52	64	61	54	49	46	45	41	32	16	--	--	--	--	--	Station, Idling Greyhouse Bus
3	04/07/83	0325	47	63	61	55	47	46	41	36	28	15	--	--	--	--	--	Station, Wind, Sewer Water
4	11/01/82	1633	51	---------		too variable to record					-------		55	59	70	83	68	Aircraft, Cars, Children at play
4	11/02/82	0018	56	54	52	52	50	52	50	52	49	32	57	58	60	61	58	Station Steam Venting
4	11/03/82	0409	41	52	51	46	39	35	34	30	25	16	41	41	41	49	42	Quiet
4	11/04/82	0253	45	50	51	48	46	42	38	35	29	19	44	45	46	46	45	Quiet
4	03/23/83	*	45	55	53	47	45	43	40	33	22	15	--	--	--	--	--	Station, Local Noise
4	04/01/83	0130	40	55	54	46	39	36	36	30	18	14	--	--	--	--	--	Quiet, Transformer Hum Sootblower Just Audible

TABLE A-4 (Cont)

			Sound Pressure Level Data, dB, re 2 x 10^{-5} N/M^2										Statistical Data, L(N) in dBA					
Location	Date	Time	dBA	31.5	63	125	250	500	1K	2K	4K	8K	L90	L50	L10	L01	LEQ	Audible Noise Sources
4	04/07/83	0104	42	56	53	51	45	42	36	27	16	11	--	--	--	--	--	Transformer Hum
4	04/07/83	0331	46	55	53	48	45	43	37	28	16	11	--	--	--	--	--	Station, Aircraft, Traffic
5	11/01/82	1633	51	--------- too variable to record -------									--	--	--	--	--	Commuter & Truck Traffic
5	11/02/82	0026	51	58	57	62	51	49	44	42	35	24	54	62	83	84	77	Station, Steam Venting Noise
5	11/02/82	1555	60	62	64	64	60	55	51	49	43	35	60	64	70	75	66	Trucks, Aircraft, Athletic Field
5	11/03/82	0417	51	58	59	56	48	46	46	45	41	31	51	51	52	52	51	General Station Noise
5	11/04/82	0257	53	56	56	54	50	47	46	47	44	34	52	53	55	56	54	Station, One Car
5	11/18/82	0131	53	62	63	61	53	50	47	44	38	19	59	54	54	55	59	Station
5	03/23/83	0146	50	62	60	57	50	48	45	39	31	19	--	--	--	--	--	Station, Steam Noise, Sootblower, Tones
5	04/01/83	0142	50	61	62	60	48	47	45	42	33	17	--	--	--	--	--	Station, Sootblower, PRV
5	04/07/83	0118	51	60	60	57	49	48	47	43	37	20	--	--	--	--	--	Station, Transformer, Airport
5	04/07/83	0338	50	59	60	59	50	47	45	38	27	13	--	--	--	--	--	Station, Aircraft
6	11/02/82	0102	52	60	59	51	50	50	48	45	38	22	52	53	55	60	53	Deaerator Vents, Occasional Traffic
6	11/02/82	1605	--------- no data ---- kids & traffic -------										63	67	75	87	72	Trucks and Cars, 20-25/minute
6	11/03/82	0424	49	59	59	52	46	43	43	41	35	23	49	49	50	51	49	Station
6	11/04/82	0302	54	57	57	52	49	49	46	46	42	30	52	53	54	55	53	Deaerator Venting
6	03/23/83	0230	50	61	60	55	51	48	45	37	25	14	--	--	--	--	--	Station, Transformer Hum
6	04/01/83	0152	No Data Obtained - Transformer Malfunction Nearby															

TABLE A-4 (Cont)

			Sound Pressure Level Data, dB, re 2 x 10^{-5} N/M^2										Statistical Data, L(N) in dBA					
Location	Date	Time	dBA	31.5	63	125	250	500	1K	2K	4K	8K	L90	L50	L10	LO1	LEQ	Audible Noise Sources
6	04/07/83	0138	49	61	59	53	46	46	45	41	30	13	--	--	--	--	--	Station, Sootblower PRVs, Transformers
6	04/07/83	0345	47	61	58	52	45	42	41	37	26	12	--	--	--	--	--	Station, Transformer East
7	11/02/82	0109	53	61	59	53	50	52	47	46	39	25	52	53	56	61	54	Station, Occasional Traffic
7	11/02/82	1613	54	65	62	60	56	55	48	45	39	27	56	58	65	67	61	Kids, Aircraft Traffic
7	11/03/82	0431	47	59	58	52	45	43	42	41	35	21	47	47	48	49	48	Station
7	11/04/82	0306	51	57	63	57	52	50	46	45	40	28	51	53	59	62	56	Airplane, Station
7	11/18/82	0142	51	59	60	53	50	49	45	41	34	15	51	51	52	53	51	Station, Deaerator Vents
7	03/23/83	0250	49	61	59	54	52	49	44	37	24	14	--	--	--	--	--	Station, Traffic, Steam Leak?
7	04/01/83	0156	48	60	61	56	46	44	43	39	25	14	--	--	--	--	--	Station, Sootblower PRV, Aircraft, Some Traffic
7	04/07/83	0149	49	60	59	54	46	47	45	39	30	13	--	--	--	--	--	Station, Sootblower PRVs
7	04/07/83	0353	49	60	59	53	47	44	44	36	23	13	--	--	--	--	--	Station, Traffic, Noise
8	11/02/82	0124	51	57	57	51	48	54	45	41	33	18	51	55	65	72	61	Station, Tanker (Tone), Traffic
8	11/02/82	1623	57	62	64	59	56	53	too much traffic				60	66	71	86	70	Commuter Traffic, Tanker (Tone)
8	11/03/82	0439	45	54	55	51	42	41	39	36	29	16	45	48	66	76	64	Station
8	11/04/82	0312	47	52	52	47	44	43	42	41	35	19	47	48	53	67	54	Station, One Passby
8	11/18/82	0150	51	58	59	51	50	48	45	40	27	15	50	51	57	71	57	Station, Car Passbys
8	03/23/83	**	47	58	57	54	47	44	40	33	23	15	--	--	--	--	--	Station, Transformer, Hum, Wind & Litter
8	04/07/83	0212	49	58	61	57	50	47	45	37	21	12	--	--	--	--	--	Station, Traffic, Air-

TABLE A-4 (Cont)

			Sound Pressure Level Data, dB, re 2 x 10⁻⁵ N/M²										Statistical Data, L(N) in dBA					
Location	Date	Time	dBA	31.5	63	125	250	500	1K	2K	4K	8K	L90	L50	L10	L01	LEQ	Audible Noise Sources
																		craft, Transformers
8	04/07/83	0400	48	60	59	56	49	46	45	36	20	12	--	--	--	--	--	Tanker Noise; Station Audible
9	11/02/82	0137	50	58	56	55	48	45	43	42	37	34	50	50	53	57	51	L St Steam Hiss, Station
9	11/03/82	0447	48	60	57	54	51	45	42	39	35	34	48	48	52	54	49	L St Steam Hiss, Station
9	11/04/82	0318	50	55	55	52	48	47	45	43	38	37	50	50	51	51	50	L St Steam Hiss, Station
9	03/23/83	**	49	64	60	56	49	45	41	37	30	29	--	--	--	--	--	No Comments Made
9	04/07/83	0229	48	61	56	52	48	44	42	41	35	33	--	--	--	--	--	Station, Transformers, Steam Hiss
9	04/07/83	0407	47	62	55	54	45	42	40	37	31	32	--	--	--	--	--	Station Transformers, Steam Hiss
10	11/02/82	0145	60	68	65	61	59	54	54	53	47	38	60	60	65	68	62	General Station Noise
10	11/03/82	0246	61	68	68	64	60	56	54	54	48	36	60	61	61	62	61	General Station Noise
10	11/04/82	0228	59	64	65	62	58	54	53	52	48	39	59	61	70	82	69	General Station Noise
10	03/23/83	0020	57	67	66	63	57	53	51	46	35	27	--	--	--	--	--	Station, Sootblower System, Idling Bus
10	04/07/83	0301	53	69	68	61	53	49	45	40	32	21	--	--	--	--	--	Station, Bar Air-Conditioning
11	11/01/82	2345	76	80	80	79	75	73	71	71	64	53	77	77	78	78	77	Station FD Fans, Auxiliary Equipment
11	11/02/82	1515	76	77	80	79	75	73	68	68	61	51	75	76	78	88	77	Station FD Fans, Auxiliary Equipment
11	11/03/82	0240	77	83	82	80	75	73	72	72	66	55	78	78	78	79	78	Station FD Fans, Auxiliary Equipment
11	11/04/82	0215	77	75	78	79	79	71	71	71	65	55	77	77	77	77	77	Station FD Fans, Auxiliary Equipment

NEW BOSTON STATION - DEIR

TABLE A-4 (Cont)

			Sound Pressure Level Data, dB, re 2 x 10^{-5} N/M²										Statistical Data, L(N) in dBA					
Location	Date	Time	dBA	31.5	63	125	250	500	1K	2K	4K	8K	L90	L50	L10	L01	LEQ	Audible Noise Sources
11	03/23/83	0000	69	82	82	74	69	64	61	57	49	40	--	--	--	--	--	Station - Sootblower System Audible
11	04/01/83	0023	69	81	82	75	71	66	62	58	50	39	--	--	--	--	--	Station, Car Passbys, No Wind
11	04/07/83	0007	67	80	83	75	68	63	60	58	54	42	--	--	--	--	--	Station
11	04/07/83	0256	68	80	79	78	70	63	61	58	53	41	--	--	--	--	--	Station Noise

NOTES:

* Readings taken between 1:00 am and 1:46 am
** Readings taken between 2:50 am and 3:30 am

6 of 6

Section A.6

Figures A-1 to A-12

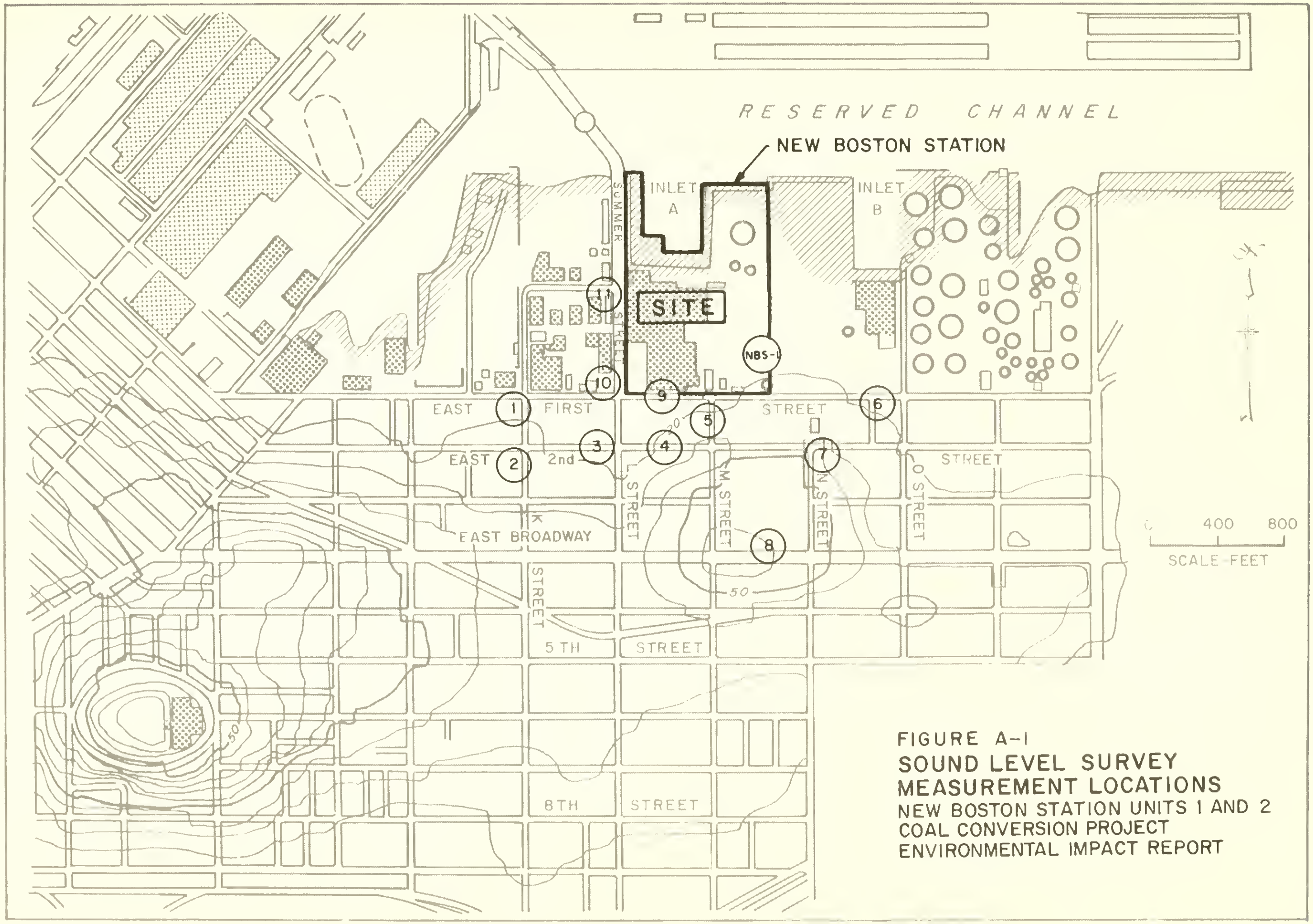
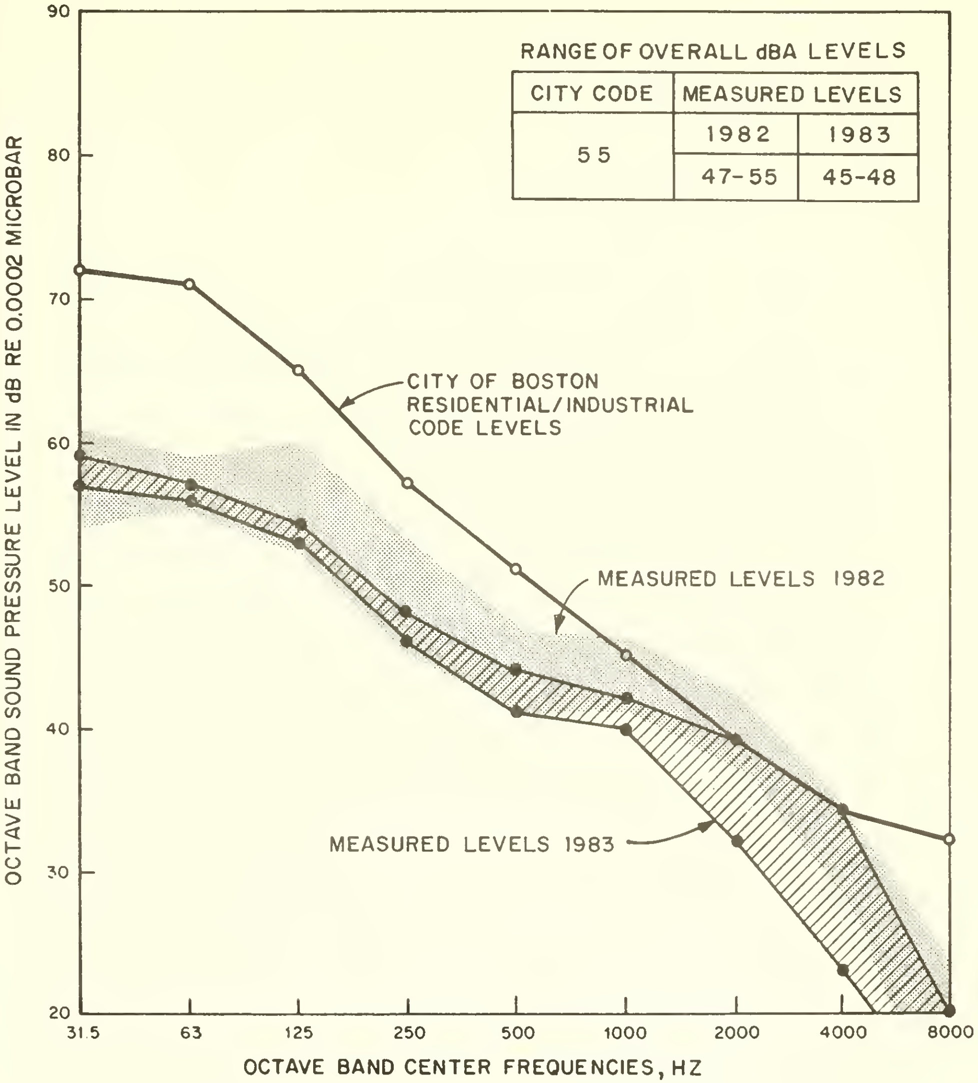


FIGURE A-1
SOUND LEVEL SURVEY
MEASUREMENT LOCATIONS
NEW BOSTON STATION UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT



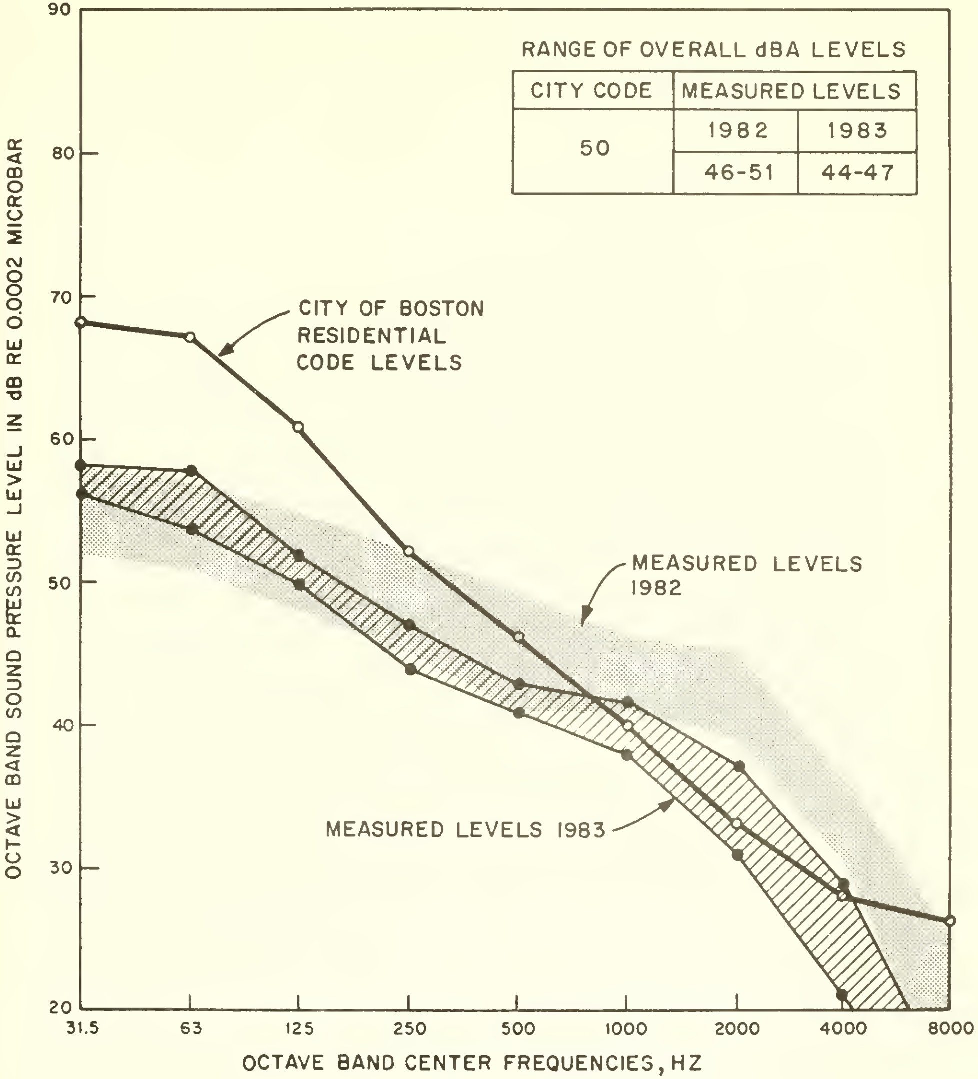
RANGE OF OVERALL dBA LEVELS

CITY CODE	MEASURED LEVELS	
	1982	1983
55	47-55	45-48

FIGURE A-2

RANGE OF NIGHTTIME OCTAVE BAND RESIDUAL SOUND PRESSURE LEVELS AT POSITION 1 (ZONE: RESIDENTIAL/INDUSTRIAL)

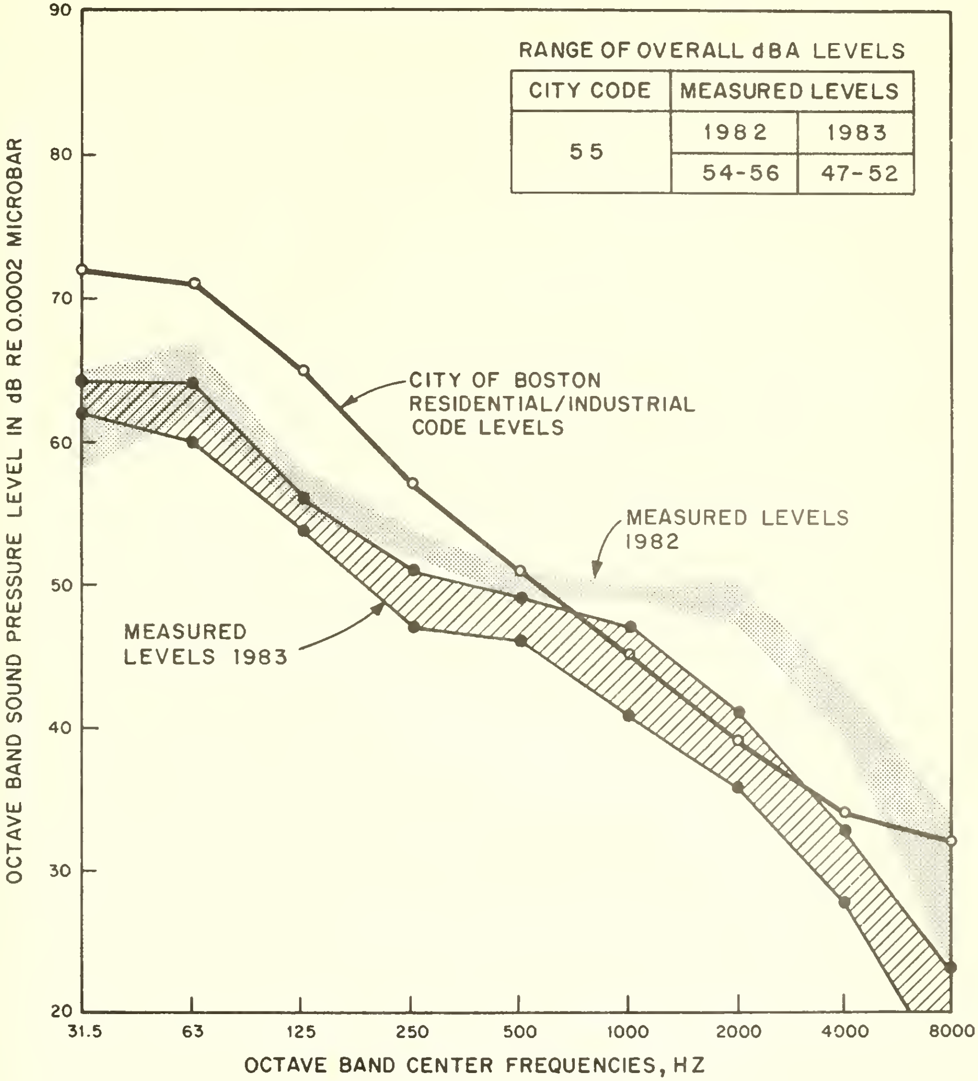
NEW BOSTON STATION UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT



RANGE OF OVERALL dBA LEVELS

CITY CODE	MEASURED LEVELS	
	1982	1983
50	46-51	44-47

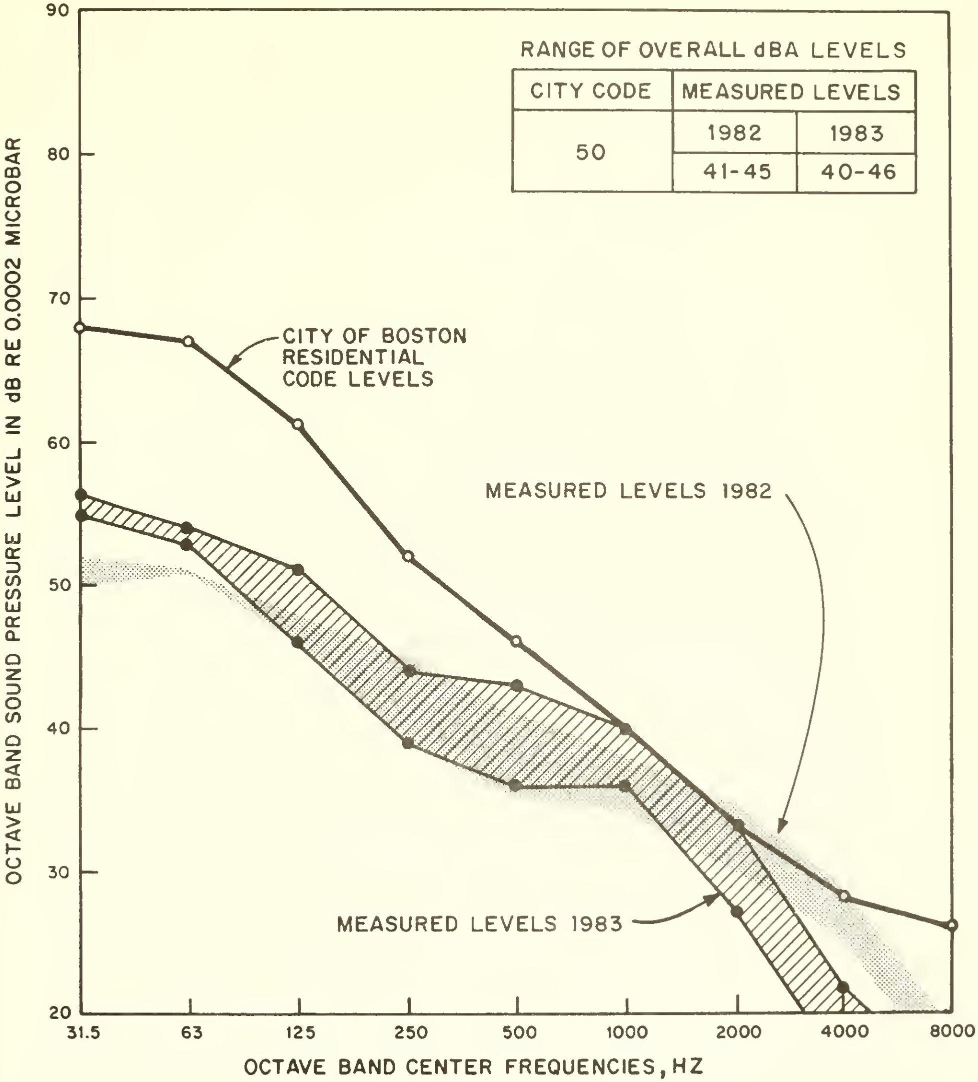
FIGURE A-3
RANGE OF NIGHTTIME OCTAVE BAND RESIDUAL SOUND PRESSURE LEVELS AT POSITION 2
(ZONE: RESIDENTIAL)
NEW BOSTON STATION UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT



RANGE OF OVERALL dBA LEVELS

CITY CODE	MEASURED LEVELS	
	1982	1983
55	54-56	47-52

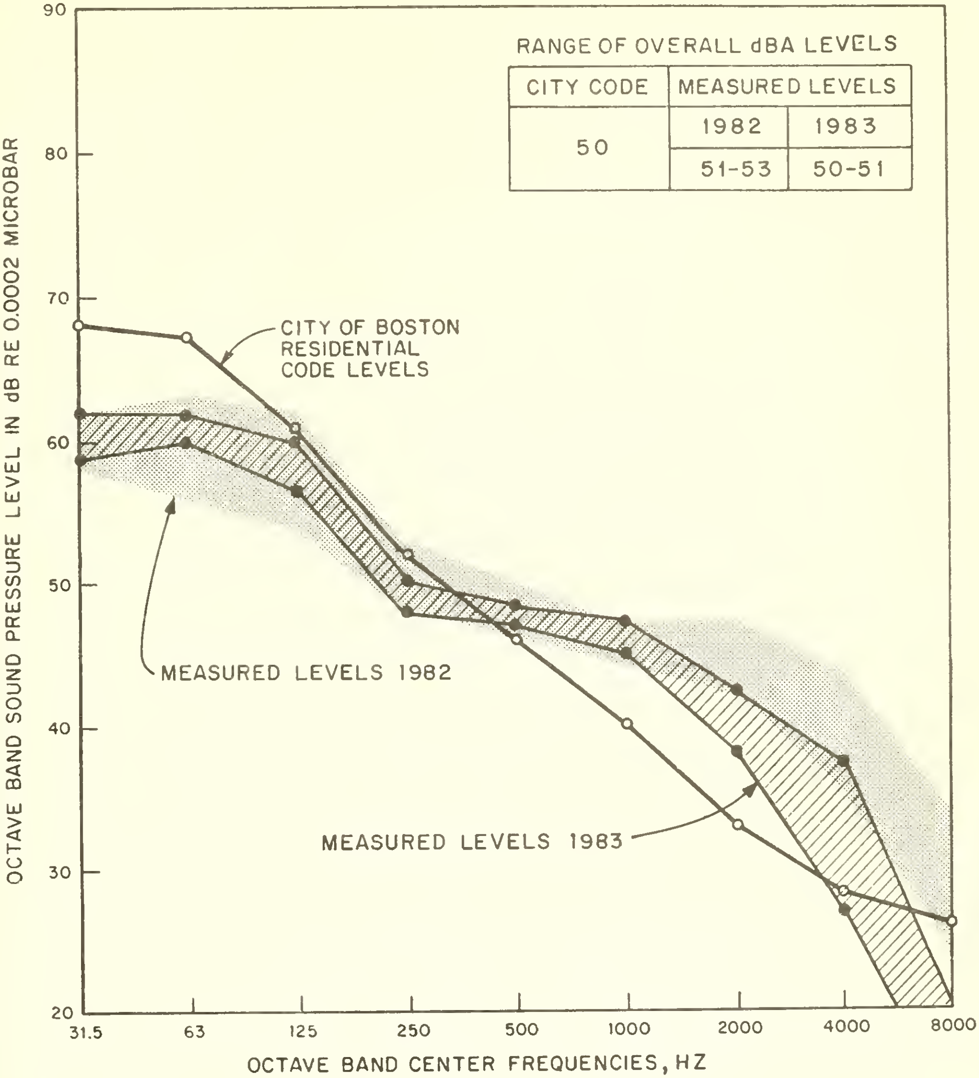
FIGURE A-4
RANGE OF NIGHTTIME OCTAVE BAND RESIDUAL SOUND PRESSURE LEVELS AT POSITION 3 (ZONE: RESIDENTIAL/INDUSTRIAL)
NEW BOSTON STATION UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT



RANGE OF OVERALL dBA LEVELS

CITY CODE	MEASURED LEVELS	
	1982	1983
50	41-45	40-46

FIGURE A-5
RANGE OF NIGHTTIME OCTAVE BAND RESIDUAL SOUND PRESSURE LEVELS AT POSITION 4 (ZONE: RESIDENTIAL)
NEW BOSTON STATION UNITS I AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT



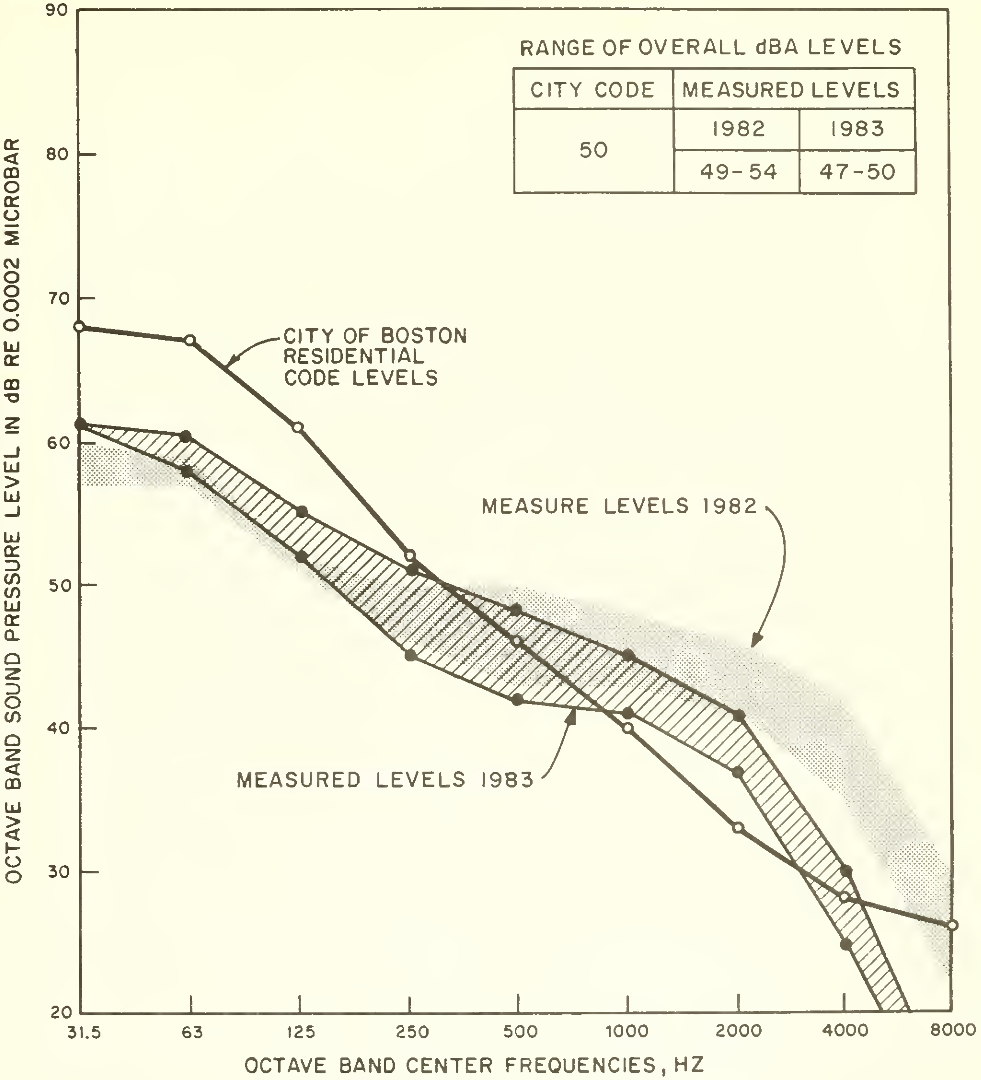
RANGE OF OVERALL dBA LEVELS

CITY CODE	MEASURED LEVELS	
	1982	1983
50	51-53	50-51

FIGURE A-6

RANGE OF NIGHTTIME OCTAVE BAND RESIDUAL SOUND PRESSURE LEVELS AT POSITION 5 (ZONE: RESIDENTIAL)

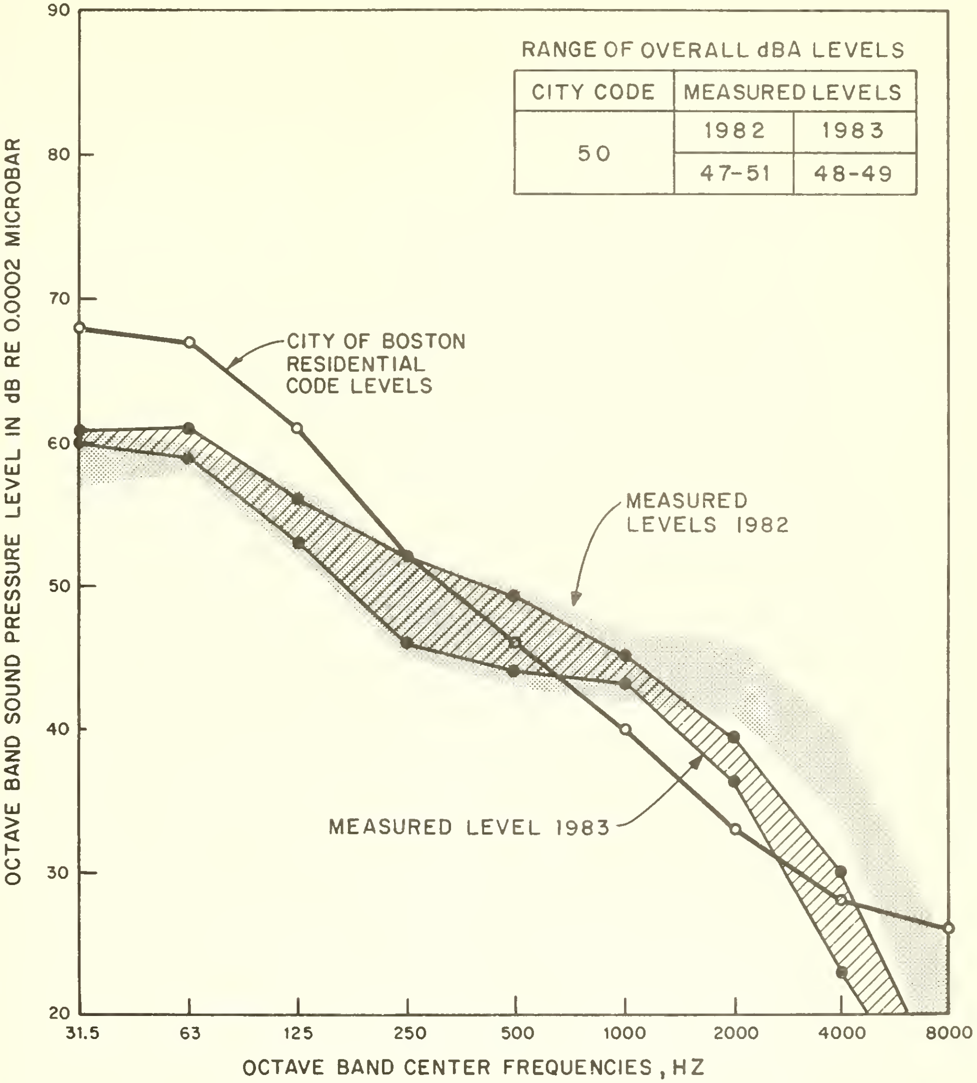
NEW BOSTON STATION UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT



RANGE OF OVERALL dBA LEVELS

CITY CODE	MEASURED LEVELS	
	1982	1983
50	49-54	47-50

FIGURE A-7
RANGE OF NIGHTTIME OCTAVE BAND RESIDUAL SOUND PRESSURE LEVELS AT POSITION 6 (ZONE: RESIDENTIAL)
NEW BOSTON STATION UNITS I AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT



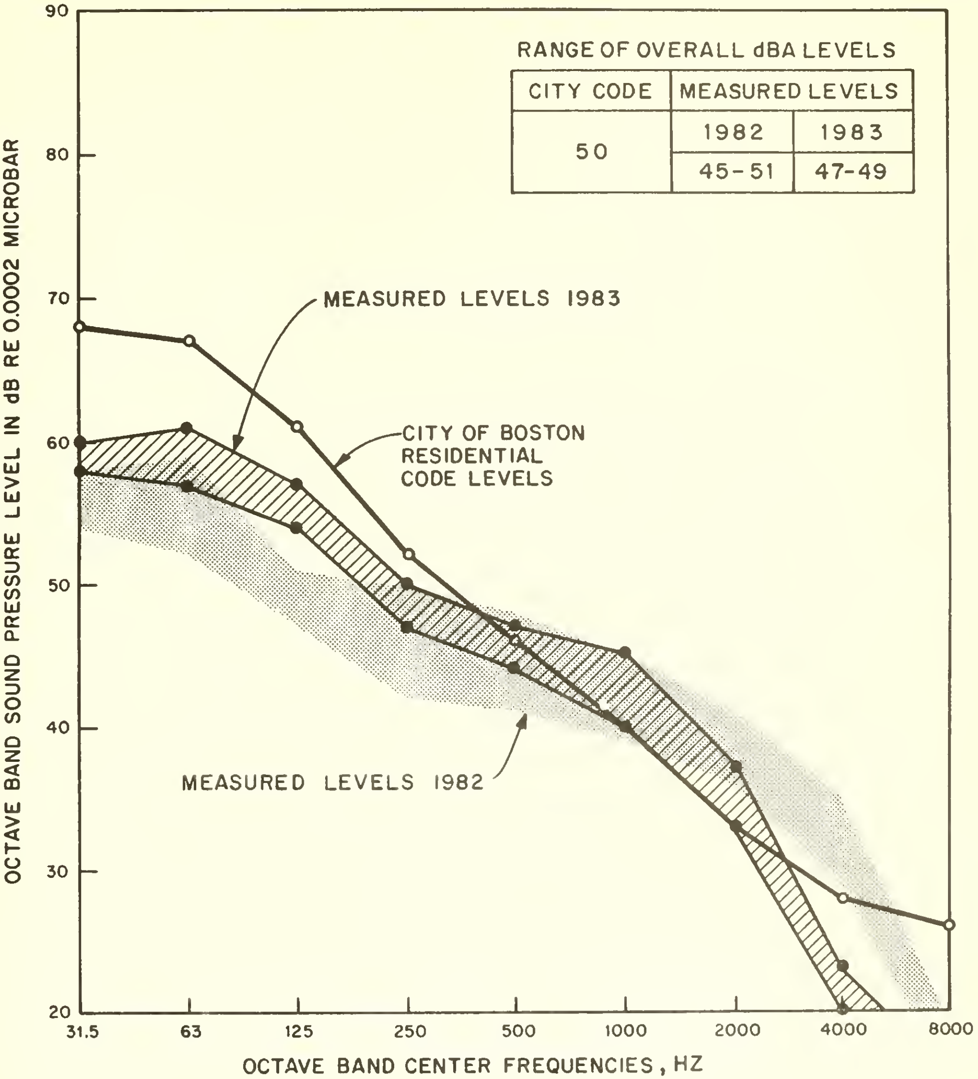
RANGE OF OVERALL dBA LEVELS

CITY CODE	MEASURED LEVELS	
	1982	1983
50	47-51	48-49

FIGURE A-8

RANGE OF NIGHTTIME OCTAVE BAND RESIDUAL SOUND PRESSURE LEVELS AT POSITION 7 (ZONE: RESIDENTIAL)

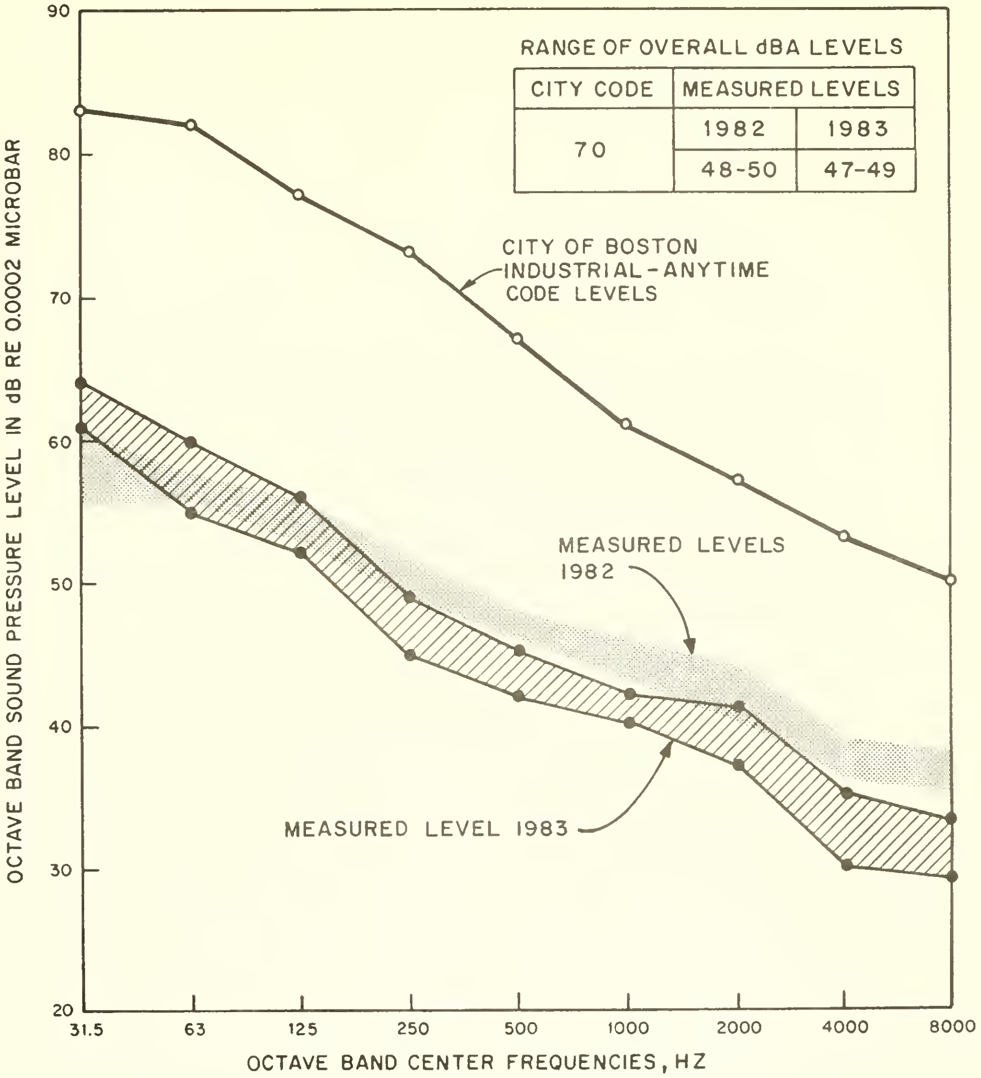
NEW BOSTON STATION UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT



RANGE OF OVERALL dBA LEVELS

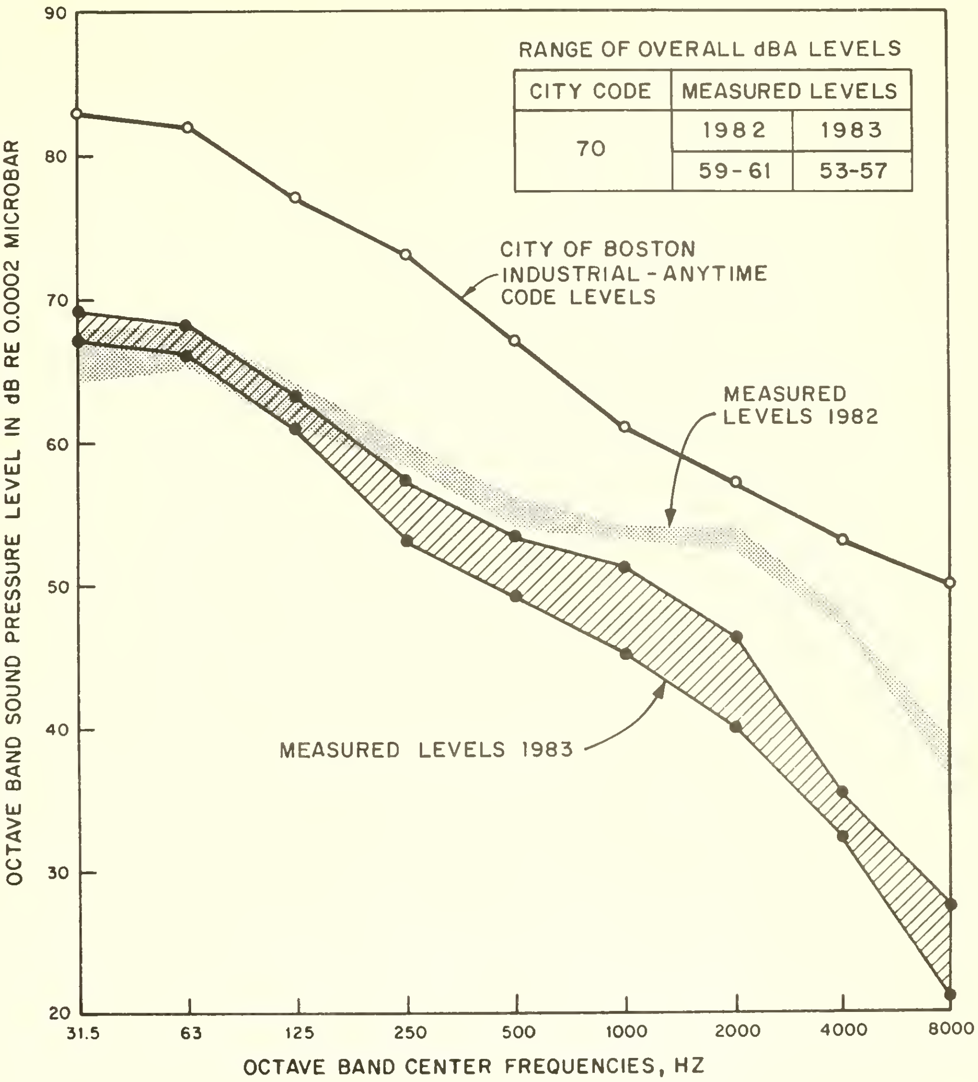
CITY CODE	MEASURED LEVELS	
	1982	1983
50	45-51	47-49

FIGURE A-9
RANGE OF NIGHTTIME OCTAVE BAND RESIDUAL SOUND PRESSURE LEVELS AT POSITION 8
(ZONE: RESIDENTIAL)
NEW BOSTON STATION UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT



CITY CODE	MEASURED LEVELS	
70	1982	1983
	48-50	47-49

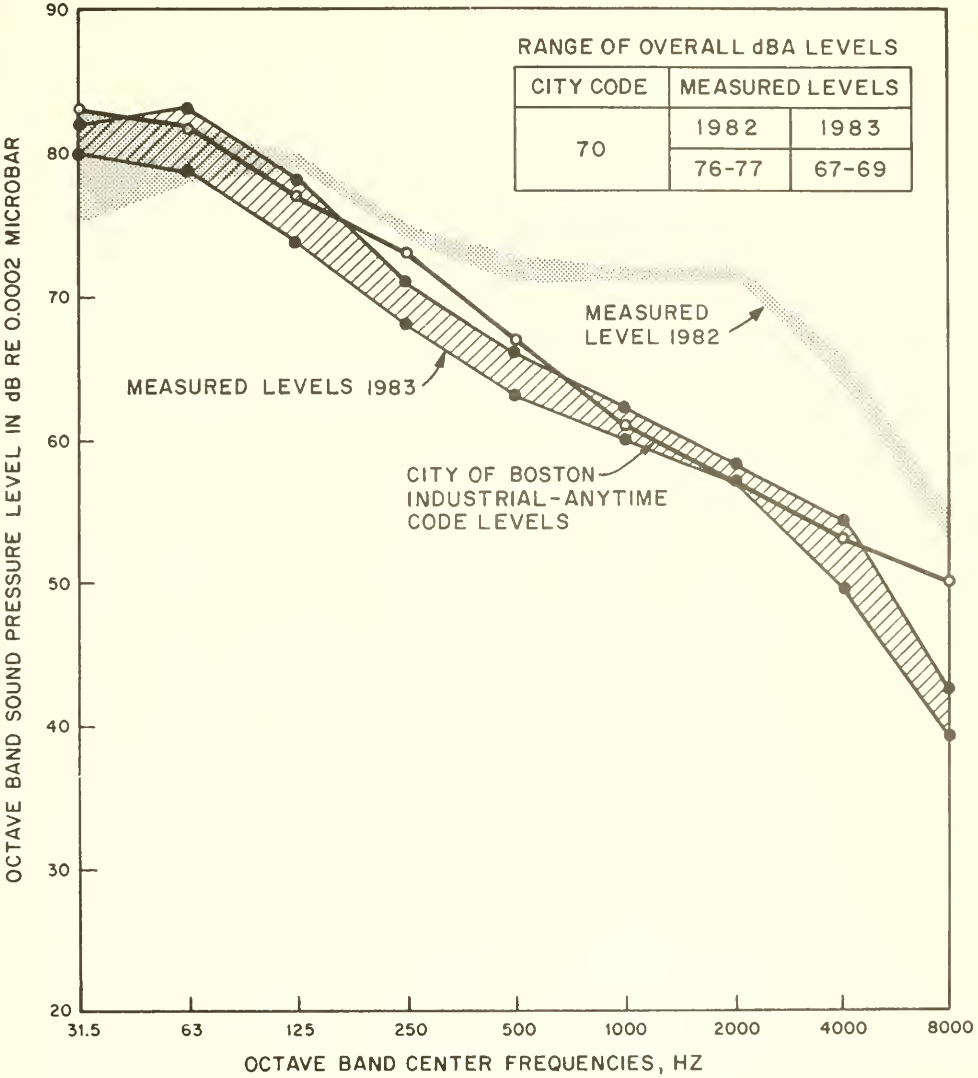
FIGURE A-10
RANGE OF NIGHTTIME OCTAVE BAND RESIDUAL SOUND PRESSURE LEVELS AT POSITION 9 (ZONE: INDUSTRIAL-ANYTIME)
NEW BOSTON STATION UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT



RANGE OF OVERALL dBA LEVELS

CITY CODE	MEASURED LEVELS	
	1982	1983
70	59-61	53-57

FIGURE A-11
RANGE OF NIGHTTIME OCTAVE BAND RESIDUAL SOUND PRESSURE LEVELS AT POSITION 10 (ZONE: INDUSTRIAL-ANYTIME)
NEW BOSTON STATION UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT



RANGE OF OVERALL dBA LEVELS

CITY CODE	MEASURED LEVELS	
	1982	1983
70	76-77	67-69

FIGURE A-12

RANGE OF NIGHTTIME OCTAVE BAND RESIDUAL SOUND PRESSURE LEVELS AT POSITION 11 (ZONE: INDUSTRIAL-ANYTIME)

NEW BOSTON STATION UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT

EA1/D1

Section A.7

Special Senate Committee Report

"Black Friday", May 13, 1960

SENATE **No. 647**

The Commonwealth of Massachusetts

REPORT

SUBMITTED BY THE

SPECIAL COMMITTEE

ESTABLISHED FOR THE PURPOSE OF
INVESTIGATING THE DOWNPOUR OF SMOKE,
SOOT, OR OIL OVER A PORTION
OF THE SOUTH BOSTON DISTRICT
OF THE CITY OF BOSTON

JULY, 1960

The Commonwealth of Massachusetts

FOLLOWING ORDER ESTABLISHING SPECIAL COMMITTEE ADOPTED IN SENATE ON MAY 16, 1960.

Ordered, That a special committee, to consist of four Senators to be designated by the President, be established for the purpose of making an investigation and study of the unprecedented downpour or discharge of smoke, soot or oil over a portion of the South Boston district of the city of Boston on May thirteenth of the current year, which constituted a menace to public health and safety and resulted in great damage to property and to person. Said committee shall determine the cause of said downpour or discharge and shall seek to determine methods of combating the same, with a view to adopting such remedial legislation as may be necessary to prevent similar occurrences. Said committee may hold public hearings, may summons witnesses, administer oaths, take testimony and may require the production of books, papers and documents. Said committee may employ such engineering assistants and counsel as it may deem necessary, and may expend for the purposes of this order such sums as may be appropriated. Said committee shall report to the Senate not later than June fifteenth in the current year the results of its investigation and study, and its recommendations.

FOLLOWING ORDER EXTENDING TIME FOR SPECIAL COMMITTEE TO MAKE REPORT ADOPTED IN SENATE ON JUNE 13.

Ordered, That the time be extended to June 30 within which the Senate will receive the report of the special committee of the Senate authorized and directed (under an order adopted by the Senate on May 16) to investigate the downpour or discharge of smoke, soot or oil over a portion of the South Boston district of the city of Boston on May thirteenth in the current year.

The Commonwealth of Massachusetts

Members of the Special Committee Established for the Purpose of Investigating the Downpour of Smoke, Soot, or Oil over a Portion of the South Boston District of the City of Boston:

Senator JOHN E. POWERS,
of Suffolk. *Chairman.*

Senator JAMES W. HENNIGAN, JR.,
of Suffolk.

Senator FRED LAMSON,
of Middlesex.

Senator MICHAEL LoPRESTI,
of Suffolk.

The Commonwealth of Massachusetts

On Friday, May 13, 1960, between 8:30 A.M. and 9:30 A.M., a portion of the South Boston District of the City of Boston was covered by a black oil-base type substance. The area subjected to this debris included from M Street and East First Street, then in a westerly direction to E Street and West First Street, then in a southerly direction to Andrew Square. The shape of the concentration was that of an ellipse and covered approximately one square mile wherein reside over 10,000 people.

This unprecedented downpour caused Senate President John E. Powers, on May 16, 1960, to offer the following order in the Massachusetts Senate, to wit: —

> "*Ordered:* That a special committee, to consist of four Senators to be designated by the President, be established for the purpose of making an investigation and study of the unprecedented downpour or discharge of smoke, soot, or oil over a portion of the South Boston District of the City of Boston on May thirteenth of the current year, which constituted a menace to public health and safety and resulted in great damage to property and to person. Said committee shall determine the cause of said downpour or discharge and shall seek to determine methods of combating the same, with a view to adopting such remedial legislation as may be necessary to prevent similar occurrences. Said committee may hold public hearings, may summons witnesses, administer oaths, take testimony and may require the production of books, papers and documents. Said committee may employ such engineering assistants and counsel as it may deem necessary, and may expend for the purposes of this order such sums as may be appropriated. Said committee shall report to the Senate not later than June fifteenth in the current year the results of its investigation and study and its recommendations."

The President appointed Senators Hennigan of Suffolk, LoPresti of Suffolk, and Lamson of Middlesex to serve with him on the Committee.

The Committee appointed William F. Coyne, Esquire, One State Street, Boston, to serve as counsel to the Committee; Robert Charles Associates, Engineers, 73 Tremont Street, Boston, to serve as consultants to the Committee, and Ruth Nelson was appointed official stenographer.

On June 13 of the current year, the Senate adopted a further order to extend the time within which the Committee shall report to on or before June thirtieth of the current year.

The Committee, acting under its authority of the Senate Order, gave notice that a Public Hearing would be held on Thursday, May 19, 1960, at 10:30 A.M., to which were invited executive and administrative employees of the Division of Sanitary Engineering, Department of Public Health, and Representative John T. Tynan, of South Boston.

Said Hearing was continued until Thursday, May 26, 1960, and, on this day, officials and expert witnesses of the Boston Edison Company and the Metropolitan Transit Authority were present.

On each of the dates of the Public Hearings, all witnesses testified under oath and in excess of five hundred pages of testimony were taken.

Testimony disclosed that the Department of Public Health, Division of Sanitary Engineering, first learned of the fallout occurrence in South Boston as the result of a telephone call from an official at the Farragut Co-Operative Bank on East Broadway, near K Street, South Boston, at about 8:55 A.M. Inspection employees of this Division were dispatched immediately to the scene, the first arriving at approximately 9:15 A.M.

Description of the fallout by observers likened it to a "black snowstorm", which completely covered the clothing of the people who were in the streets. The pedestrians sought escape from the fallout by going into stores and doorways. Automobiles, sidewalks and streets in the affected area were similarly covered. Photographs taken at the time of the fallout show visible proof of the type and density of the coverage by the soot. These photographs appear on Pages 49, 50, 51, 52, 53, 54 and 55 of this report.

An inspection employee of the Division of Smoke Abatement testified that " . . . it was the worst (situation) I had ever encountered in my thirty-one years of state service . . . " .

Of course, there were more exaggerated descriptions from persons questioned in the area, i.e. " . . . the streets were ankle deep in soot", etc. However exaggerated this latter description is, it could become a tragic truth if the pollutants concentrated in the atmosphere were to settle out in frequent intervals.

It cannot be overemphasized that the visual deposit in South Boston on May 13 was caused by precipitation of contaminants generally existing at all times in the air and which people breathe throughout the year. The atmospheric conditions were such that, on this particular day, the material was forced to settle out in a concentrated area.

Air pollution, however, unlike the tragic incident in South Boston, is not an intermittent or accidental occurrence but, rather, a constantly increasing menace. By our very ignorance of the conditions existing, and neglecting proper control of the sources, we are allowing the air we breathe to turn into a deadly combination of materials which may cause irreparable damage to public health.

Testimony further showed the weather on the morning of May 13, 1960 to be overcast with intermittent rain and a very low ceiling (about 100 feet), which obscured the tops of the tall smoke stacks at both the Boston Edison Plant and the Metropolitan Transit Authority Power Plant. The wind was from the northeast with a velocity of five to ten miles per hour at ground level. There was a unique meteorological condition present in a stationary cold front at approximately 600 feet in height in this immediate area. This inversion exerted a stabilizing influence on the atmosphere below, preventing stack effluents from penetrating above this altitude. With the moderate wind conditions prevailing at that time, the soot-fall incident occurred in a concentrated area.

Field observations and tests of the fallout in the area were described, in testimony, as follows: —

> " . . . When rubbed with fingers, it was gritty; therefore, it must have resulted from coal burning . . . "
>
> " . . . When rubbed, it was gritty but it also smeared; hence, it was an oil soot . . . "

Microscopic analysis by the Department of Public Health indicated the soot to be conclusively that of a combustion process involving oil as a fuel with some indication that the burning of coal was a contribution.

The consensus was that the material which resulted in the "black snow", soot, or fallout in the South Boston area were products of inefficient combustion. Pictures submitted are descriptive of typical concentration in the fallout area. The estimated quantities, by weight, and the area covered indicated the source to be a plant of large capacity of which there are two in the area. The Boston Edison and the Metropolitan Transit Authority power plants are both of sufficient size to qualify; but, the Metropolitan Transit Authority plant was the only one burning a fuel consisting of coal and oil simultaneously.

The testimony disclosed that the first smoke abatement law was enacted in 1910, which created a smoke inspection district, consisting of the City of Boston and five neighboring communities; subsequently, the boundaries were expanded and presently include Boston and thirty other municipalities. This smoke control system is administered by the small staff of the Division of Smoke Inspection, Department of Public Health. This Division is responsible for enforcement governing the intensity and duration of visible smoke emissions from stacks in the district.

The law governing smoke control in the Metropolitan District permits only the control of visible smoke discharged from stacks to the extent specified by statute. State Smoke Inspectors do not possess authority to enter private property in performing their duties. However, it must be noted that the evidence disclosed that there has never been a single instance where a state inspector was refused admission to a plant. Since the power of state inspectors is limited, it is then necessary for them, when the situation warrants, to seek the aid of local health inspectors to assist in investigations.

Since the inspectors in the Smoke Inspection Division have control only of visible smoke, the weather conditions of Friday, May 13, 1960, presented a most peculiar problem for, as was stated earlier in this report, the low ceiling obscured the tops of the stacks of the two largest plants in the contaminated area from view. This situation raised a technical problem as to jurisdiction for purposes of action, i.e., state authority re smoke emission or local authority re abating a nuisance via the health department.

However, the evidence shows that this jurisdictional problem did not, in any way, cause delay on the part of any authority to move speedily to control and abate the "black snowstorm"; for, if a local health agency requests advice or assistance, the Department, through the Division of Sanitary Engineering, renders all possible help within budget limitations. In the instant case, the City of Boston Health Department requested, and received, aid.

The Division of Sanitary Engineering, Department of Public Health, has submitted a detailed and graphic report of its investigation, findings and conclusion surrounding this matter and which report is made a part of this Committee Report, appearing from Page 12 to Page 48.

At this time, the Committee wishes to extend its appreciation to the Department of Public Health and the employees who gave of their time and talent to the investigation, evaluation and preparation of this comprehensive report of the "South Boston Fallout Incident". The Committee is deeply grateful for this herculean accomplishment on the part of the Department.

All who testified were in accord that the residue which covered the South Boston area emanated largely from some type of oil burning device. In this particular area, there is a large concentration of possible sources of air pollution. For example: —

(1) Ships:
    Army Base, Castle Island and other private docking facilities.
(2) Navy Annex:
    Power Plant.
(3) Metropolitan Transit Authority:
    Generating Station.
(4) Boston Edison Company:
    Station No. 4.
(5) Boston Fire Department:
    Fire School.
(6) White Fuel.
(7) Cable Rubber Products Company:
    Heating Plant.

(8) Army Base:
Power Plant.

Regarding the tragic occurrence in South Boston, all but (3) and (4) are eliminated due to one or more of the following reasons: Wind direction was wrong, distances too great, stacks within sight of eyewitnesses and this quantity of smoke would have been immediately reported, was not operating, or could demonstrate proper combustion.

However, none of the above-listed sources can be eliminated from the overall problem of air pollution in the metropolitan area and the above list is, in no way, meant to limit the possible sources.

Examination of witnesses and records from the Boston Edison Company, the Metropolitan Transit Authority, Public Health Department, and an inspector of the Department of Public Safety revealed that: —

(1) Nothing unusual occurred at the Boston Edison Plant at L and East First Streets, South Boston, and that this plant did not discharge any more than its usual amount of ash and soot to the air.

(2) The Metropolitan Transit Authority was burning both oil and coal simultaneously, not a common practice (nor is this, by expert testimony, considered an efficient practice) in one of its boilers (#22) during the critical period; that, on this same boiler (#22), certain mechanical apparatus for the detection of smoke and/or proper combustion was not functioning. When this practice is followed, it is at best an inefficient combustion process.

The top of the stack serving boiler #22 was obscured by the low ceiling, thus preventing the personnel at the Metropolitan Transit Authority plant from observing the color of the smoke.

(3) Since boiler #22 is provided with forced draft and natural draft, maintenance of the breeching and stack in an airtight condition is paramount to proper operation. Inasmuch as the breeching of this furnace contains large holes, it is conceivable that poor combustion resulted in the furnace due to the improper removal of the products of combustion through lack of sufficient draft.

(4) The "Fallout" pattern indicates that the source was

from a point east of the Boston Edison Plant.

(5) The unique meteorological phenomena which existed prevented this soot formation from rising and being dispersed over a greater area if at all but rather, in great part, the inversion caused the fallout to occur in a concentrated pattern over a small area.

(6) The soot which fell on South Boston on the morning of Friday, May 13, 1960, was the result of incomplete combustion of carbonaceous materials, probably both coal and oil, although it is difficult to determine with certainty which of these fuels (or both) were involved, or the relative percentages of each.

(7) On the basis of the evidence, coupled with the complete report of the Division of Sanitary Engineering, Department of Public Health, which has been made a part of this Committee's Report, the Committee finds that certain natural phenomena and mechanical failures of indicating equipment at the Metropolitan Transit Authority Station on East First Street, South Boston, combined to result in the South Boston soot fallout incident and to, jointly, be the cause thereof.

The Commonwealth of Massachusetts

Division of Sanitary Engineering
Department of Public Health

REPORT

ON

SOUTH BOSTON SOOT-FALLOUT INCIDENT

MAY 13, 1960

JUNE 21, 1960

TABLE OF CONTENTS

PAGE

Summary and Conclusions 16

I. Description of Soot Fallout Incident 18
  Timetable 20
  Map No. 1 22

II. Meteorological Conditions 21
  Table No. 1 24
  Map No. 2 25
  Map No. 3 26
  Fig. I 27

III. Further Description of the Nuisance 28

IV. Potential Suspect Sources in the Vicinity 31
  Table No. 2 33

V. Elimination of Certain Sources from Further Consideration 34

VI. Pertinent Facts Relative to Remaining Suspect Sources . 35
  Table No. 3 38

VII. Certain Aspects of Fuel Combustion 39

VIII. Efficiency of Combustion and the Production of Soot by the South Boston Station of the MTA . . . 43

Acknowledgements 48

The Commonwealth of Massachusetts

SUMMARY AND CONCLUSIONS

A. *Summary*

On May 13, 1960, between 8:30 A.M. and 9:30 A.M. the East Broadway section of South Boston was subjected to an intense fallout of black sooty particles that dirtied the surfaces upon which they landed and created a great nuisance, inconvenience, and some damage by soiling of exposed property in the vicinity.

The weather in South Boston during this period of time was overcast with intermittent rain and drizzle, and the clouds were so low that they obscured the tops of the tall smoke stacks of two large power plants (Boston Edison and MTA) located a short distance upwind of the area which was subjected to gross fallout.

The fallout limits were delineated on a map by drawing lines defining the limits of equal but arbitrary intensity. This produced a classical fallout pattern as shown on Map No. 1 on page 22. The map shows the limit of fallout, as determined through observations of detectable fallout on automobiles and puddles while driving slowly through the streets of South Boston, and the limit of gross fallout.

Extensive investigation into the meteorological conditions prevailing at the time of the fallout indicates that there was a fairly stationary weather front over South Boston at an altitude of approximaely 600 feet. It is believed that the emissions from all stacks in South Boston, including those of both the Boston Edison Plant and the MTA plant, were subject to the prevailing ground winds and that the stacks and their emissions did not penetrate the front aloft.

The shape of the fallout pattern, together with knowledge of prevailing wind directions and speeds, indicated that the two large power plants in South Boston were suspect sources of the soot. Both these plants, it was assumed, had the potential capacity to produce the amount of soot that fell on South Boston during the incident. Careful consideration of the fallout pattern and meteorological data implicated the MTA plant to a greater degree than the Boston Edison plant.

Chemical and Microscopical analyses of the fallout samples collected revealed to the Department that the fallout material was largely soot resulting from incomplete combustion of coal and/or oil.

Soiling characteristics of known amounts of ash and soot deposits were related to data, records, and first hand knowledge of soot that fell out on South Boston. From this data as a basis it was calculated that as little as 500 to 600 lbs. of soot (mixed with some ash) would have been an adequate amount to cause the nuisance.

It is known that when carbon (the chief constituent of coal or oil) is burned in power plants, a small percentage of the carbon supplied does not combine with oxygen to produce carbon monoxide or carbon dioxide, but instead is separated from the hydrocarbon molecule by thermal cracking to form soot. Even in power plants where thermal efficiencies of 75 to 80% are achieved in practice, some of the uncombusted carbon is discharged as unburned particles or in the form of soot together with the fly ash.

When plants such as Boston Edison or the MTA operate with thermal efficiencies in the range of 75-80%, the amount of ash and soot emitted from the stacks in one hour is substantial. This amount (estimated to be in the range of 75 to 150 lbs. per hour for Boston Edison and 50 to 100 lbs. per hour for the MTA) has a noticeable soiling effect upon the environs, but the soiling is usually, to a degree, expected and philosophically acceptable to the public as a necessary contaminant of the ambient air of industrial and large metropolitan areas. However, a radically increased amount of contaminant above these base levels, when accompanied by conditions of poor atmospheric diffusion resulting in a high concentration of fallout, would meet with public displeasure and result in a nuisance such as that which occurred in South Boston on May 13, 1960.

Review of the plant records of the Boston Edison plant for the period from 8:00 A.M. to 10:00 A.M. reveal that conditions and data as recorded indicated nothing unusual; the plant was apparently operating with good efficiency and not discharging more than its normal amount of ash and soot to the ambient air.

A review of the MTA plant records and calculations of boiler efficiencies from records of fuel consumed and heat produced revealed that conditions of poor combustion probably existed during the period from 8:30 A.M. to 9:30 A.M. on May 13, 1960 resulting in the formation of an estimated few thousand pounds of soot and the discharge to the ambient air of an unusually large and excess amount (several hundred pounds) with subsequent soot fallout.

B. *Conclusions*

On the basis of the facts, evidence, and findings set forth above and in the body of this report the Department of Public Health is of the opinion that certain natural phenomena and mechanical failures combined to result in the South Boston soot fallout incident and to jointly be the cause thereof. The possibility of human errors can not be ignored as a possible contributing factor.

- The MTA and Boston Edison plants were recognized as having the capacity and ability to produce the large amount of soot necessary to accomplish the "fallout."
- The stacks of both Boston Edison and MTA extended into the clouds during the period of concern and direct observation of emissions therefrom was not possible, while the tops of lower stacks at other nearby and possibly suspect sources were subject to direct observation and detection.
- Meteorological conditions were such as to produce (1) very poor vertical diffusion of the stack discharges, (2) probable coning of the plume, and (3) a wind direction which carried the plume and fallout directly to a heavily populated area.
- Study of the fallout pattern and detailed meteorological data coupled with knowledge of particle subsidence in the atmosphere supports the theory that the soot issued from a "continuous point source" in the proximity of the MTA plant and easterly of the Boston Edison plant.
- The burning of coal and oil together in the MTA Boiler No. 22 (during the period from 7:30 A.M. to 9:00 A.M.) is a prac-

tice which is recognized as difficult to properly control and one which frequently results in "smoke" (soot formation).

- Mechanical and visual means usually available to the firemen to assist them in maintaining good combustion in MTA Boiler No. 22 and to minimize the emission of excessive smoke therefrom were inoperative or impossible.
  1. The CO_2 recorder was not operating.
  2. The Smoke Density recorder was not operating.
  3. The low clouds obscured the top of its tall stack and made direct observation of the emissions therefrom impossible.
- The MTA plant produced and discharged to the ambient air an excessive amount of soot during the period from 8:30 A.M. to 9:30 A.M. This soot constituted the major portion of the black snow-like agglomerated particles of carbon that fell on South Boston on May 13, 1960.

I. DESCRIPTION OF THE SOOT-FALLOUT INCIDENT

At 8:55 A.M. on May 13, 1960, the Smoke Inspection Division of the Department of Public Health received a telephone call reporting the existence of a serious air pollution and fallout condition, continuing at the time, over a large area of South Boston.

The Supervising Smoke Inspector of the Department immediately proceeded to South Boston to commence investigations into the extent of the alleged nuisance and to ascertain if possible the source of the agglomerated black particles that were falling like snow in the area. The inspector arrived at the scene at 9:15 A.M. and immediately reported the serious nature and extent of the incident to the central office. As a consequence several engineers from the Division of Sanitary Engineering immediately were ordered to South Boston to assist in the investigation.

The weather in South Boston on "Friday, the 13th", was overcast with intermittent rain and a cloud ceiling down as low as approximately 100 feet. (A detailed discussion of the meteorological conditions existing at the time is given in the following section of this report).

The fallout complained of consisted of both small and large agglomerated particles of black carbonaceous material that fell like small snow flakes to the ground with the rain and drizzle. The material had the appearance and smudginess of oil soot, was non-wettable, and, when mixed mechanically with rain drops, smeared and soiled surfaces and materials as though it were dilute black ink. Some witnesses of the phenomenon testified that quick, on the spot examination of the fallout led them to the conclusion that the soot was from an oil combustion source while others were of the opinion that it was the result of poor coal combustion. The black particles fell, as stated above, like snow flakes and caused a visible deposit on all horizontal and some inclined surfaces. It floated and accumulated on the surface of puddles of water and collected in substantial quantities in the street gutters where the rainfall runoff water became impounded by obstructions and depressions in the gutter. At such points of accumulation, it had the appearance, except for its color, and the consistency of the fluffy top of a milk shake.

As shown on Map No. 1 (on page 22) the fallout extended over an area of approximately one square mile, while it was gross over an area of approximately 0.2 of a square mile.

The fallout was so heavy and of such a nature that pedestrians left the streets and took cover in stores and doorways. Soon after the fallout stopped many people washed down their building fronts, the sidewalks, and their automobiles to minimize the possible damage that potentially might have resulted from the soot.

The first inspector, upon arrival on the scene, was shocked by the seriousness of the situation; he had never seen anything like it in his thirty-one years of experience. Although, because of the clouds, he could not see the tops of certain tall smoke stacks of two large power plants in the vicinity and upwind of the fallout, he was well aware of their presence and of their eligibility as possible sources of the sooty material falling to the ground. He immediately telephoned officials of the plants, advised them of the fallout then occurring, and requested that they immediately check their fuel burning equipment then being used that might be the cause of the nuisance.

Testimony of company officials and direct interrogation of plant employees produced denials by them as to their having any knowledge of conditions or operations in their plants that could have caused the fallout nuisance. They reported that plant operations and practices on that day were normal and routine and that it was their belief that their plants did not create the fallout.

Upon arrival at the scene, other Department personnel confirmed the seriousness of the situation and proceeded to:

A. Visit and inspect the two major power plants in the area (viz., Boston Edison and the MTA).

B. Collect samples of the fallout from automobile tops and ground surface accumulations.

C. Inspect for extent and limits of the fallout and to document such limits on maps of the area.

D. Notify the Department of Health of the city of Boston of the situation and suggest that inspectors thereof come immediately to South Boston and take whatever steps possible to minimize the damage that might result from the nuisance. As a result of this suggestion, the Department of Public Works and the Fire Department of Boston were contacted; both of these Departments sent equipment and personnel to flush and wash away the deposit from some of the sidewalks and streets.

E. Establish a close watch over visible smoke stacks in the area for violations of smoke emissions and possible indications of the source of the fallout soot.

F. Institute a complete and thorough investigation into the matter with a view to determining the source of the fallout that caused such a nuisance.

A timetable of significant events that occurred on the morning of May 13, 1960 is given below:

Time	*Event*
8:30 A.M.	Start of soot-fallout
8:55	Department of Public Health received first notice of situation by telephone
9:15	First inspector from Dept. arrived on scene
9:15	Inspector notified Division of Sanitary Engineering
9:20±	Inspector contacted Boston Edison by telephone
9:25±	Inspector contacted MTA by telephone

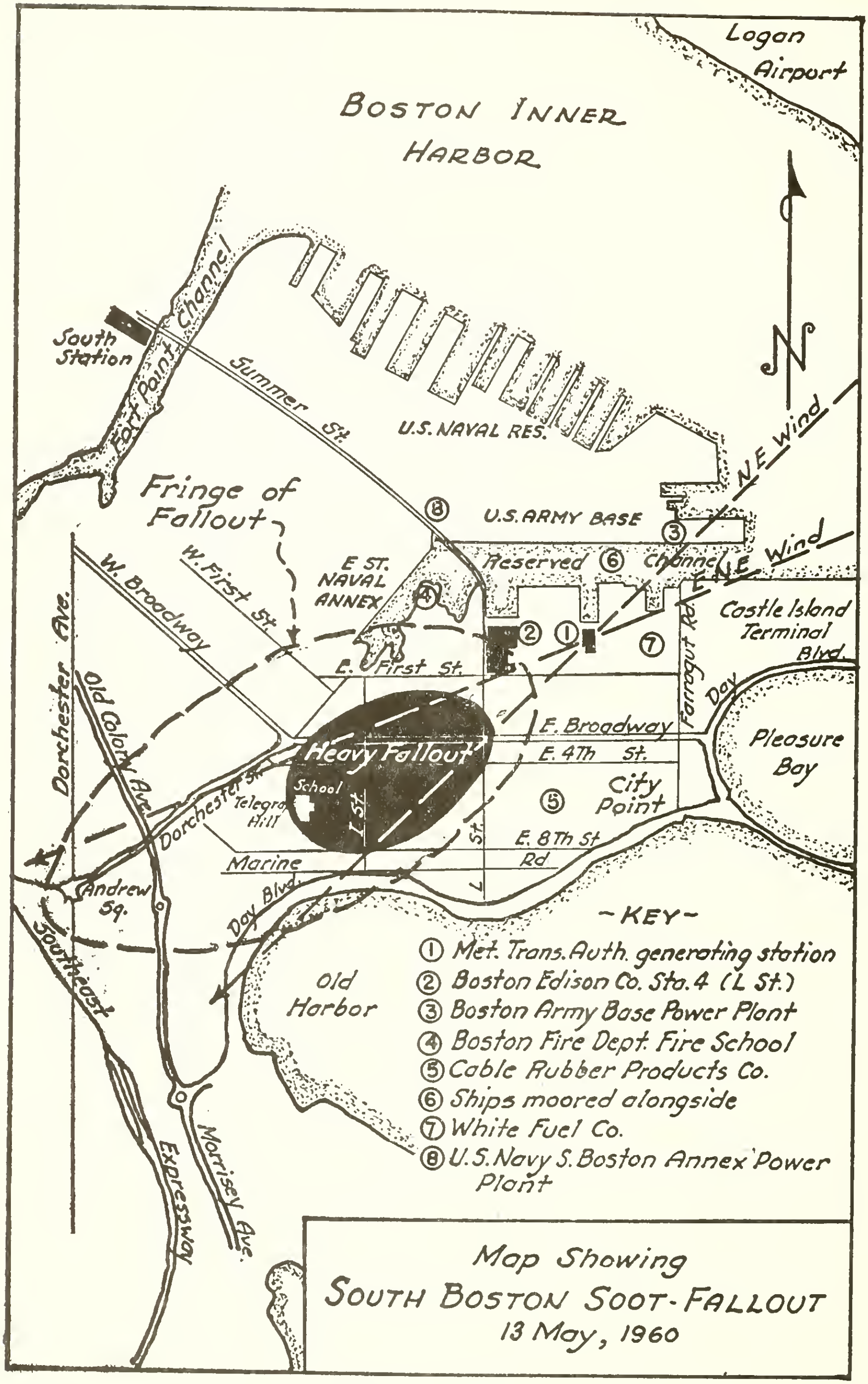
9:35	Heavy fallout began to subside
9:50	Last few flakes of fallout fell in the vicinity of 700 E. Broadway
10:00±	Department of Public Health of City of Boston notified and certain actions were recommended to them.

II. METEOROLOGICAL CONDITIONS

A. *General Conditions in the Boston Area May 11 through 13, 1960.*

At about 7:00 A.M. on May 11, 1960, a shallow cold front was present in the vicinity of Caribou, Maine. At about this time the weather in Boston had commenced to deteriorate in advance of the front which was proceeding southerly. There were intermittent fog and rain showers in the Boston area with variable winds. On the evening of the 11th the ground trace of the front extended along a line from Caribou, Maine, to Burlington, Vermont. A weak warm front was located south of Boston. By the morning of May 12 the cold front extended along a line from Eastport, Maine, to Burlington, Vermont, moving southerly. The winds south of the front ground trace and above the front aloft were southeasterly to easterly while the winds north of the trace and below the front were northeasterly to easterly. By the evening of the 12th the front was located in the Lawrence-Newburyport area and it passed through Boston in the very early morning of the 13th. The weather in Boston had further deteriorated to a condition of low persistent clouds with intermittent very light showers. The accompanying weather may (Map No. 2 on page 25) shows the approximate position of the front during the 12th and 13th of May at the times indicated on the map. The accompanying sketch map (Map No. 3 on page 26) of the Boston-Quincy area shows more precisely the location of the front as determined by observations of wind speed and direction at several stations in the area. These observations are presented in the following table Table No. 1 on page 24).

The profile of the front at 8:00 to 10:00 A.M., May 13, 1960, which had changed from a shallow cold front to more of a stationary front is shown in Gig. No. 1 on page 27; the "profile" is a


Logan Airport
Boston Inner Harbor
South Station
Fort Point Channel
Summer St.
U.S. Naval Res.
N.E. Wind
E.N.E. Wind
Fringe of Fallout
U.S. Army Base
Reserved Channel
E St. Naval Annex
W. First St.
W. Broadway
Dorchester Ave.
Old Colony Ave.
E. First St.
Castle Island Terminal
Farragut Rd.
Day Blvd.
E. Broadway
E. 4Th St.
Heavy Fallout
School
Telegraph Hill
Dorchester St.
L St.
City Point
E. 8Th St
Marine Rd
Pleasure Bay
Andrew Sq.
Southeast Expressway
Morrisey Ave.
Old Harbor
-KEY-
① Met. Trans. Auth. generating station
② Boston Edison Co. Sta. 4 (L St.)
③ Boston Army Base Power Plant
④ Boston Fire Dept. Fire School
⑤ Cable Rubber Products Co.
⑥ Ships moored alongside
⑦ White Fuel Co.
⑧ U.S. Navy S. Boston Annex Power Plant
Map Showing
South Boston Soot-Fallout
13 May, 1960

Map N^o 1

shape, slope, and position of this boundary between the cold and vertical section taken along a line normal to the front and extending northwesterly. It represents the best probable estimate of the the warm air masses. As was stated above the winds below and to the north of the boundary will be generally northeasterly; those above and to the south generally southeasterly.

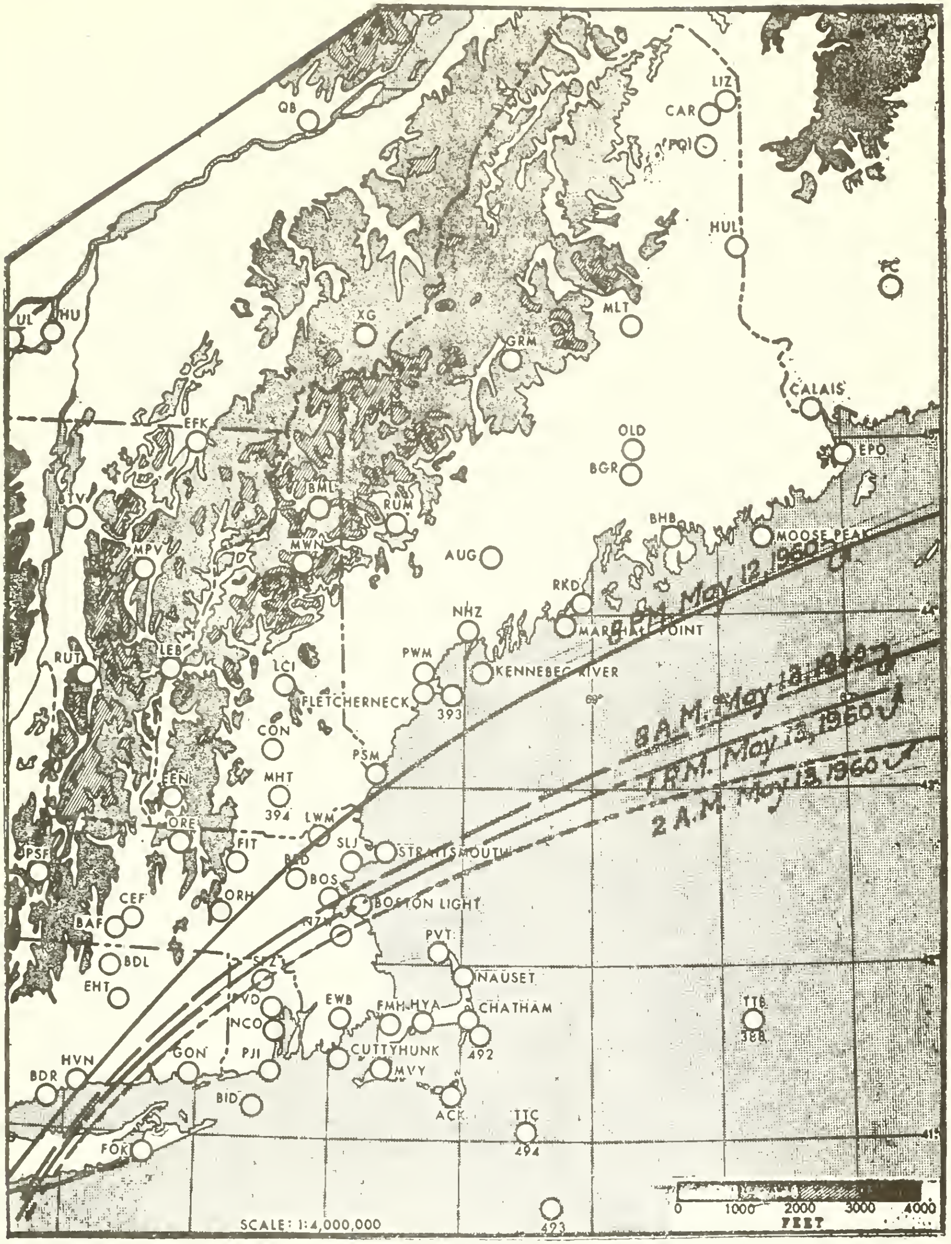
The trace from the continuous wind recorder located at the L Street Station of the Boston Edison Company indicates that a condition of moderate stability prevailed at the elevation of the detecting instrument. This condition, together with the low cloud conditions and the inversion aloft probably produced a coning type plume from stacks in the area.

B. *Conclusions Regarding Meteorology*

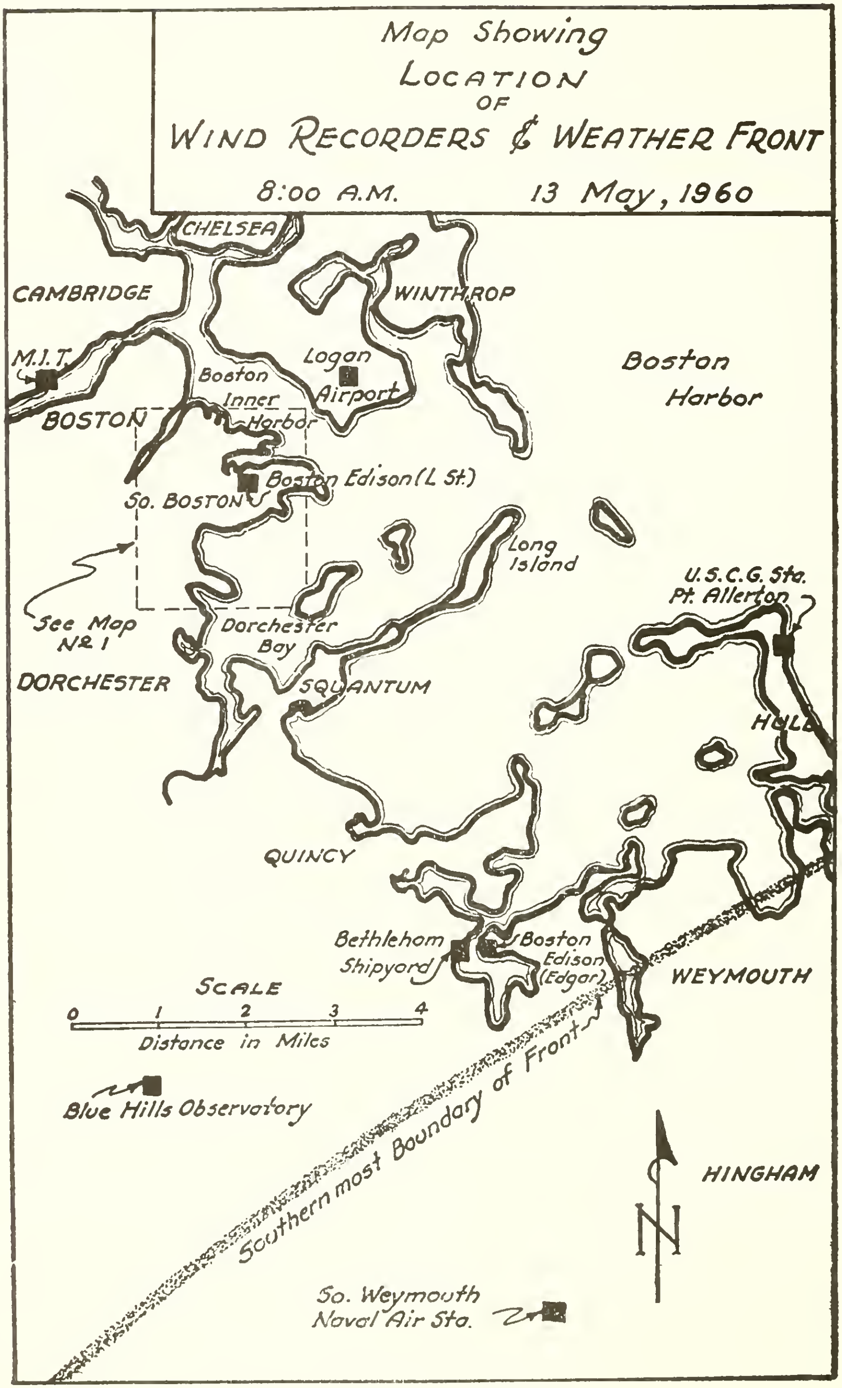
It is concluded that the frontal boundary, and thus the accompanying inversion and the southeasterly winds aloft, was considerably above the tops of all the stacks in the South Boston area on the morning of May 13, particularly between the hours of 8:00 to 10:00 A.M. The stability of the atmosphere below the front, the lack of gustiness as evidenced by continuous recordings of wind velocity, and the presence of the inversion aloft were not conducive to diffusion of stack effluent into the atmosphere. This inversion, at an approximate altitude of from 500 to 700 feet over South Boston at that time, in addition to exerting a stabilizing influence on the atmosphere below, would also have tended to prevent emissions from sources below it from rising out of the zone of northeasterly winds. Therefore, the Department is of the opinion that the wind direction affecting stack effluents at the South Boston area on the morning of May 13 was generally from the northeast with some easterly tendency.

TABLE No. 1

STA.	M.I.T.		LOGAN AIRPORT		EDISON (S. Boston)		BLUE HILLS OBSERVATORY		BETHLEHEM SHIP BLDG.		NAVAL AIR STATION (S. Weymouth)	
Grnd. Elev.	10′		10′		10′		635′		10′		150′	
Inst. Elev.	140′		33′		80′		650′ ±		75′			
Time	Dir.	Sp.	Dir.	Sp.	Dir.	Sp.	Dir.	Sp.	Dir.	Sp.	Dir.	Sp.
0640	E	6			NE	8						
0645	E	5			NE	8						
0650	E	5			NE	8						
0655	E	5			NE	8						
0700	E	5			NE	8						
0705	E	8			NE	8						
0710	E	9			NE	8						
0715	E	7			NE	8						
0720	E	7			DIRECTION PEN STUCK NNE	8					S	6
0725	E	7			X	8						
0730	E	4			X	8						
0735	E	4			X	8						
0740	ENE	5			X	8					SSW	5
0745	ENE	3			X	8						
0750	ENE	6			X	8						
0755	ENE	5			NE	8						
0800	ENE	5	ENE	8	NE	8	SE	8	NNE	2	SSW	3
0805	ENE	6			NE	8						
0810	ENE	3			NE	8						
0815	E	2			NE	8	SE	8	NNE	2.5		
0820	E	2			NE	8						
0825	ENE	5			NE	9						
0830	E	5			NE	10	SE	7	NE	1		
0835	E	3			NE	9						
0840	ENE	9			NE	10						
0845	E	11			NE	8	SE	6	NNE	2		
0850	ENE	13			NE	8						
0855	ENE	10			NE	10						
0900	E	10	NE	15	NE	9	SE	6	NNE	2	S	2
0905	E	11			NE	9						
0910	ENE	3			NE	11						
0915	E	3			NE	12	SSE	7	NNE	4		
0920	ENE	7			NE	9						
0925	E	12			NE	11						
0930	ENE	3			NE	8	SSE	8	NNE	1		
0935	ENE	9			NE	10						
0940	ENE	9			NNE	9						
0945	ENE	4			NNE	10	E	7	NNE	4		
0950	ENE	9			NE	10						
0955	ENE	11			NE	10						
1000	E	9	ENE	13	NE	10	E	5	NNE	4	S	4



Map Showing
APPROXIMATE LOCATIONS & PROGRESS
of
COLD FRONT OF May 12-13, 1960


Map Showing
Location
of
Wind Recorders & Weather Front
8:00 A.M. 13 May, 1960
CHELSEA
CAMBRIDGE
WINTHROP
M.I.T.
Logan Airport
Boston Inner Harbor
BOSTON
Boston Harbor
Boston Edison (L St.)
So. BOSTON
Long Island
U.S.C.G. Sta. Pt. Allerton
See Map No 1
Dorchester Bay
DORCHESTER
SQUANTUM
HULL
QUINCY
Bethlehem Shipyard
Boston Edison (Edgar)
WEYMOUTH
Scale
0 1 2 3 4
Distance in Miles
Blue Hills Observatory
Southern most Boundary of Front
HINGHAM
N
So. Weymouth Naval Air Sta.

Map No 3

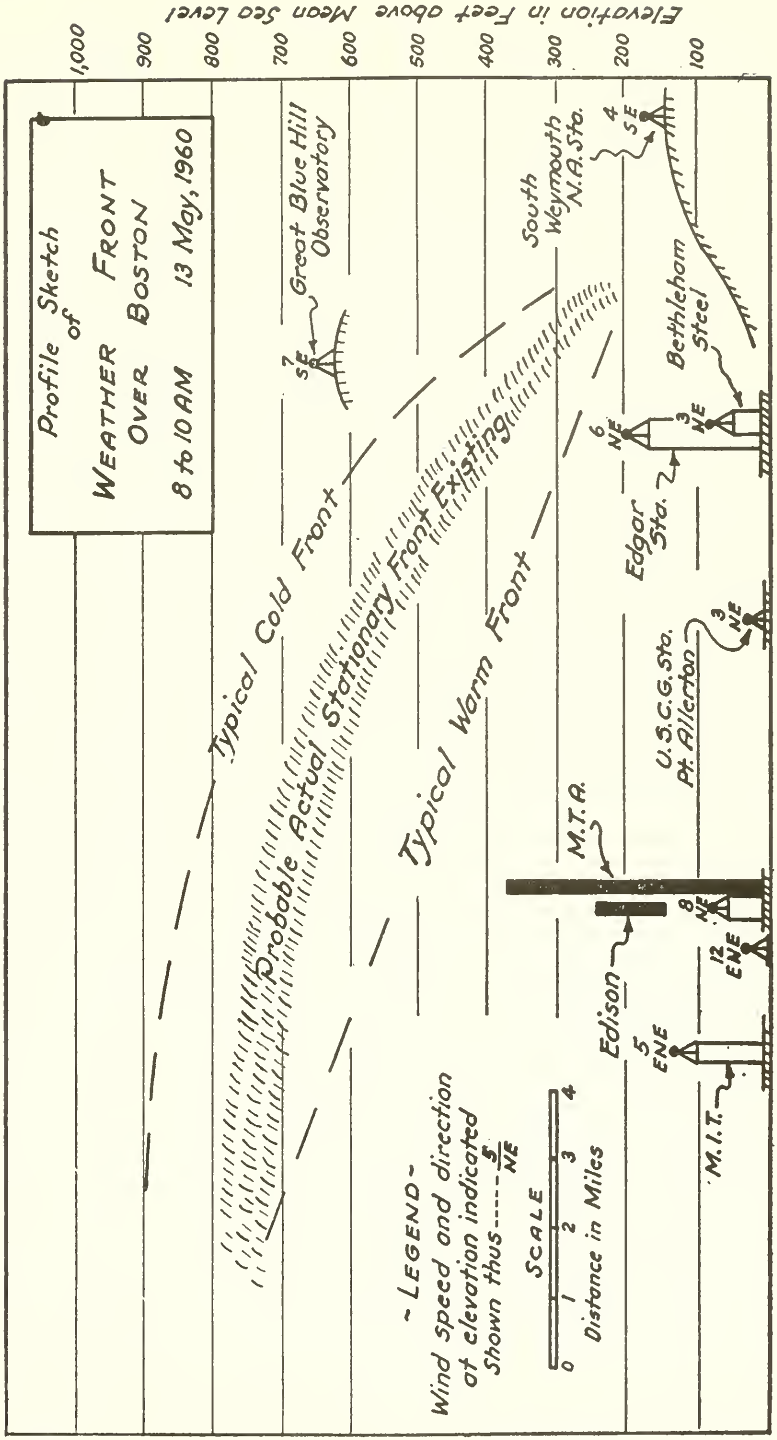

Elevation in Feet above Mean Sea Level
1,000
900
800
700
600
500
400
300
200
100
Profile Sketch of Weather Front Over Boston
8 to 10 AM 13 May, 1960
Great Blue Hill Observatory
7 SE
South Weymouth N.A. Sta.
4 SE
Typical Cold Front
Probable Actual Stationary Front Existing
Typical Warm Front
6 NE
3 NE
Bethlehem Steel
Edgar Sta.
U.S.C.G. Sta. Pt. Allerton
3 NE
M.T.A.
8 NE
12 ENE
Edison
5 ENE
M.I.T.
~LEGEND~
Wind speed and direction at elevation indicated Shown thus----5/NE
SCALE
0
1
2
3
4
Distance in Miles

Figure No 1

III. FURTHER DESCRIPTION OF THE NUISANCE

A. *The Extent and Description of the Sootfall*

1. *Map.* The (accompanying) map showing the pattern of distribution of soot deposits in South Boston was determined by Department personnel on the morning of May 13. The deposits of soot on the ground formed a very definite pattern. The limits of the readily observable deposits from an ellipse whose major axis lies in the direction of the prevailing winds. It extends from a point between M and N Streets between East First and East Second Streets in the direction of the prevailing wind to a point southwest of Andrew Square. In width it extends from West First Street near F Street to Columbia Road at about I Street. Within this area of readily observable fallout is located a smaller area of very dense fallout which also forms a rough ellipse whose major axis coincides with that of the larger ellipse, but whose center is shifted somewhat to the northeast. This area of heavy fallout extends along the major axis from East Broadway at L to Telegraph Hill and in width from East Second Street near H Street to East Eighth near I Street.

The area of heavy fallout described by the smaller ellipse is approximately 5,000,000 square feet while that of the larger ellipse is approximately 25,000,000 square feet (0.2 sq. mi. and 1.0 sq. mi. respectively).

2. *Conclusions.* From the evidence presented by the map of sootfall distribution the Department concludes that the fallout emanated continuously from a fixed point source located along a line extending generally (northeasterly) from the center of the fallout area, located approximately at East Fourth and H or I Streets. By "point source" is meant a single source or a group of sources close enough to one another so that at a short distance their effluents may be considered to have originated from a single source. Since it is not possible to accurately estimate the settling velocity of the soot particles due to uncertainties in size and bulk density thereof it can only be said that this source would most probably be located a distance empirically equal to about ten times the height of the point of release from the center of maximum fallout.

B. *The Nature of the Material*

1. *Samples Collected.* The following is a tabulation of samples of soot collected by Department personnel from various locations in South Boston on May 13.

   a. East Broadway —
      Large quantities (approximately 1½ pints) of soot removed from surface of puddles in the south gutter near 709 East Broadway across from the Farragut Cooperative Bank.

   b. 709 East Broadway —
      Window sill

   c. Gutter on East First Street, south side between M & L Streets

   d. Roof of L Street Station, Boston Edison Company, east side towards East First Street

   e. Top of stand pipe —
      Yard of C. H. Sprague & Son Company

   f. Puddle in Sprague Yard

   g. Car roof in Sprague Yard

2. *General Observations.* In the area of heavy sootfall horizontal surfaces were observed to be thoroughly blackened by the deposits. The soot floated on water and it appeared to be relatively non-wettable. To the touch it contained a certain amount of gritty material but also smeared readily leaving a black smudge which was very difficult to remove. On the basis of the appearance and "feel" of the material, some experienced observers were of the opinion that it was an oil soot while others stated that it came at least in part from coal.

3. *Analyses*

   a. *Microscopic analysis.* The microscopic analysis of the above listed samples of soot demonstrates conclusively that a combustion process was involved and gives definite indication of the involvement of oil combustion with some indication that the burning of coal may have also contributed to the sootfall. These examinations also demonstrated the presence of a considerable amount of material typical of carbon black which most probably originated from a process of incomplete combustion.

b. *Chemical analysis.* Chemical analysis of the soot sample collected by the Department, and spectrographic analysis conducted by Jarrell-Ash of samples of soot, fly ash and oil collected by the Boston Edison Company indicate very little, if any, Vanadium which might be expected to constitute a significant percentage of the ash residue from the proper combustion of the particular fuel oil that was being burned by most of the potential sources in the area. The absence of this material does not, however, preclude the incomplete combustion of oil as a potential source of the soot since its absence can be logically explained. Analysis for other metals in the ash, which constituted about 20 per cent of the soot, led to the conclusion that the combustion of coal was probably involved to some extent in the sootfall incident. The fact that approximately 80 per cent by weight of the soot was combustible matter is further indication that a process of incomplete combustion led to its formation. These analyses are presented as an appendix to this report.

4. *Conclusions.* Therefore the Department is of the opinion that the soot which fell on South Boston on the morning of May 13 was the result of incomplete combustion of carbonaceous materials, probably both coal and oil, although it is difficult to determine positively which of these fuels was most significantly involved.

C. *Estimate of Quantity of Soot Deposited.*

1. *Blackening of Surfaces by Soot.* The Department has determined that a deposit of approximately .05 grams of finely divided soot (carbon) formed by incomplete combustion will thoroughly soil a one square foot area of a clean surface and feels that this quantity of material per unit area (.05 grams per square foot) is a good estimate of the density of soot coverage in the area of heavy fallout.

2. *Total Deposit.* It is calculated from the quantity mentioned above that approximately 500 to 600 pounds of soot fell on the central or heavy fallout area in South Boston for the period of approximately one hour on the morning of May 13. With somewhat less certainty it is further estimated that approximately 100 pounds or more of soot fell on the remainder of the area shown on Map

No. 1. This corresponds to an estimated total sootfall in South Boston of some 700 pounds, more or less.

D. *Conclusions*

1. *Source nature.* The responsible source must have been burning coal and/or oil at the time of the incident. The amount of fuel required is determined to have been considerable so the source must have been fairly large. It is further felt that a point source was involved, the term "point source" including a close concentration of several sources.

2. *Source location.* The source must have been located in a general northeast to east-northeast direction from the center of the fallout area and probably was located a distance upwind of said center equal to approximately 10 times the height of the point of its release.

3. *Summary.* The above conclusions in regard to nature and location of the source permit a tentative finding (which will be supported in sections IV and V) that either the South Boston Generating Station of the MTA or the L Street Station (Station #4) of the Boston Edison Company, or both, must have been primarily responsible for the sootfall nuisance.

IV. POTENTIAL SUSPECT SOURCES IN THE VICINITY

A. The department determined the various fuel burning installations of substantial size and in the vicinity of and located generally upwind of the area of soot fallout. These plants were visited and inspected by department personnel, records were examined, and appraisals were made relative to their potential of being the cause of the subject soot fallout.

B. The locations of these plants are shown on Map No. 1 on page 7 of this report.

C. The installations visited and inspected are listed below with the code number and name of each as used in this report.

Number	*Code Name*	*Name and Address*
1	MTA	Met. Transit Authority Generating Station East First Street, South Boston
2	Boston Edison Co.	Boston Edison Company (Sta. No. 4) L Street South Boston
3	Army Base	Boston Army Base Power Plant — Summer Street South Boston
4	Fire Department	Boston Fire Department (Fire School) East First Street South Boston
5	Cable Rubber	Cable Rubber Products Company East Sixth & N Streets South Boston
6	Ships	Ships Moored along side at Army Base and/or under way in the harbor
7	White Fuel	White Fuel Company East First Street, South Boston
8	Navy Annex	U. S. Navy — South Boston Annex Power Plant Summer Street, South Boston

TABLE NO. 2
FACTUAL DATA ON SUSPECT SOURCE INSTALLATIONS

Item	MTA 22 23	Boston Edison	Army Base	Fire Dept.	Cable Rubber	Ships	White Fuel	Navy Annex
1. Type of Fuel Used:								
Infrequent but routine use of coal and oil together	X	—	—		—	—	—	—
Oil — Venezuelan #6 — from White Fuel	X	X	X	Open Fire	X		X	
Coal — Pulverized Bituminous	X	X						
Coal — Bituminous with underfeed stoker — pounds per hr.	8,400							X
2. Fuel Burning capacity: gals. oil per hour	6,600	15,750	1,560					
pounds coal per hour	73,000	162,000						
3. Smoke stack: Type	Metal	Brick	Brick		Brick	Metal	Metal	Metal
Height	372′	250′	165′		75′	100′	30′	70′
4. Air cleaning equipment (E.P.: Electrostatic Precipitator)	E.P.	E.P.	None		None	None	None	None
5. Recording Equipment:								
CO_2	X	—	X		—	—	—	—
Smoke Density	X	X	—		—	—	—	—
Steam flow — air flow	X	X	X		—			X
Fuel consumption:								
Integrating	X	X	X		X		X	—
Rate	X	—	—		—		—	—
Flue gas temperature	X	X	X		—		—	X
Steam temperature	X	X	X		—		—	X
6. Air Supply:								
Natural Draft	X		X		X	—	X	
Induced Draft	— X	X			—	—	—	X
Forced Draft	X X	X			—	—	—	X
7. Physical Condition of Plant	Poor	Excel.	Excel.	—	Good		Good	Fair
8. Normal Thermal Plant Efficiency. $(E = \frac{\text{Heat Output}}{\text{Heat Input}})$	73%	83%						

V. ELIMINATION OF CERTAIN SOURCES FROM FURTHER CONSIDERATION

A. *General*

It is reasonable to eliminate from further consideration as a possible source several of the installations and operations cited in Section IV. The pattern of the fallout, which was described in some detail in Section I, its shape, size, location and extent, are considered classically typical of the fallout pattern from an elevated point source. Such fallout ordinarily occurs at a distance of several stack heights downwind from such a source. Typically, little or no material is deposited immediately proximate to the source but with distance the deposit exhibits an increase in density to a point where it then decreases in density in the downwind direction.

All sources in the area would be affected by the prevailing northeasterly winds. The responsible source or sources must therefore have been generally to the northeast of the center of the fallout pattern.

B. *Sources Nos. 4, 5, 6 and 8.* (Refer to Section IV)

The probable general location of the source as discussed above would tend to eliminate sources four, five, and eight (viz. Fire School, Cable Rubber, and Navy Annex). The local distribution would tend to eliminate from further consideration ships under way in the harbor (source number six), since the fallout from a moving ship occurring over a period of at least one hour would have had a distribution related to the course of a moving source. Further, the stacks of ships are typically less than 100′ above sea level, and an emission from such a stack would be expected to create a maximum deposit concentration within 1000′ or less of the ship's position at a given time. Also, some material would be deposited fairly close to the vessel, perhaps within a few hundred feet. It is thus obvious from the distribution and location of fallout that it is highly improbable that the soot originated from a vessel, either moving or moored in the Reserve Channel. Furthermore, the tops of vessel stacks would have been below the bottom of the cloud layer, which was at an elevation of approximately 150′ to 200′ on the morning of the 13th, and any emission of sufficient magnitude and duration to have created the sootfall condition would have been seen and reported. This has not occurred.

Furthermore, source No. 4, the Fire School, has been shown to have not been in operation at the time of the occurrence of the sootfall, source No. 8, the Navy Power Plant, was burning coal in the underfeed stokers and the soot which was deposited on South Boston definitely contained oil and was not characteristic in any way of material which could normally be expected from an underfeed stoker, thus further eliminating this source.

C. *Source No. 3.* (Refer to Section IV)

Source No. 3, the power plant of the Boston Army Base, is located in an upwind direction which did not preclude it from further consideration as a potential source. However, the stacks being 165 ft. high would place the occurrence of the actual center of the fallout some 35 stack heights downwind and place the first indication of significant fallout at about 17 stack heights downwind; such facts do not satisfy fallout calculations. In addition the plant is in excellent condition, all instrumentation was operating and no indication could be found of the occurrence of poor combustion. Therefore, source No. 3 was eliminated from further consideration.

D. *Source No. 7.* (Refer to Section IV)

The heating plants of the White Fuel Company (source No. 7) are equipped with short stacks. The center of the fallout, had it come from this source, would measure some 80 stack heights downwind with the closest deposit occurring approximately 20 stack heights downwind, which is again improbable. Further, these are low stacks, readily observable from the ground even under the conditions of low ceiling which occurred on the 13th of May, and it is reasonable to assume that any emission therefrom of sufficient magnitude and duration to have produced the fallout would have been detected and reported.

VI. PERTINENT FACTS RELATIVE TO REMAINING SUSPECT SOURCES

(M.T.A. and Boston Edison; Sources No. 1 and 2)

A. Certain facts relative to the M.T.A. and the Boston Edison plants are pertinent in the determination of the source of the fallout. These facts are presented in the following table (No. 3 on page 38) to simplify evaluation thereof.

B. Discussion of Tabulated Pertinent Facts

1. The following is a discussion of the significance of the above referred to tabulated facts.
2. Re: M.T.A.

The fact that the M.T.A. plant is located at approximately the probable ten-stack-height distance from the center of heavy fallout, directly in line and upwind on the major axis of the determined soot-fallout pattern, and some distance upwind of any fallout on the ground strongly suggests the M.T.A. as the probable continuous point source of the soot.

It should be noted that both units No. 22 and 23 of the M.T.A. plant went on line at approximately 7:30 A.M.; No. 22 was fueled by both coal and oil until about 9:00 to 9:15 A.M. when the feeding of coal is believed to have been stopped; No. 23 was burning oil and was shut down at 9:15 A.M. Thus both a change in fuel and shut down of a boiler occurred at this plant shortly prior to the time that the soot fall started to subside.

The electrostatic precipitator used for removal of fly ash when coal is used for fuel is said to have been in operation while coal and oil were being used in No. 22. The electrostatic precipitators are not efficient for removal of carbon particles, such as soot resulting from incomplete combustion, and for this and other reasons (e.g., low concentration of fly ash, fire hazard, etc.) are not usually operated when oil alone is being used. The electrostatic precipitator being used in conjunction with Boiler No. 22 until about 9:15 A.M. is believed to have resulted in removal of most of the coal and oil fly ash from the flue gas stream but would have removed only smaller amounts of carbon soot that possibly were being formed as a result of poor combustion of the coal and oil being fired.

Examination of plant records for Boiler No. 23 revealed that good combustion conditions were probably being maintained in this unit and that it was not producing an unusual and excessive amount of oil soot.

The burning of coal and oil simultaneously in the M.T.A. furnaces is an infrequent practice which is routinely performed to assure workable condition of the coal burning equipment. Experts in combustion who were consulted by the Department are unanimously of the opinion that proper combustion of pulverized coal and oil together in the same furnace is difficult and frequently results in formation of black smoke (soot). Further, when such is the case, unburned particles of coal act in a "sand-blast" cleaning manner upon the tubes and certain other portions of the unit to free soot deposits to the flue gas stream.

Boiler unit No. 22 was being fueled until approximately 9:00 to 9:15 A.M. with a combination of coal and oil. The smoke density and CO_2 recorders on this unit were not operative at the time and therefore could not be used to assist in the maintenance of efficient combustion or in the checking for soot-smoke formation. And since the top of the M.T.A. stacks were in the clouds, the customary practice of checking for smoke emission by means of direct observation, using mirrors, also could not be employed. It is very possible that this unit could have been forming and discharging soot during this subject period with the operating personnel being unaware thereof.

The unit (No. 22) is not provided with induced draft in addition to forced draft as in the case of No. 23 and No. 21. Furthermore large holes in the breechings resulting from corrosion and inadequate maintenance lessen the amount of air that can satisfactorily be supplied to the furnace by natural draft for combustion purposes. It is not unusual for these units to be operated with positive pressure over the fire; this frequently occurs when the furnaces are being "pushed to the limit" and at such times gases and smoke discharge through openings into the boiler room.

3. Boston Edison

Examination of Boston Edison records revealed that no units were either put on or taken off line during the period in question.

TABLE NO. 3

TABULATION OF PERTINENT FACTS RELATIVE TO MTA AND BOSTON EDISON PLANTS

Pertinent Facts (May 13, 1960 — 8:00 A.M. to 10:00 A.M.)	MTA Boiler Unit No.				Boston Edison Boiler Unit No.				
	21	22	23	24	66	68	74	75	76
1. Boiler Unit in Use	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Went on Line		7:30 A.M.	7:30 A.M.	—	7:50 A.M.	7:50 A.M.	(—— 24 ——)		
Was Shut Down		6:00 P.M.	9:15 A.M.	—	9:05 P.M.	9:05 P.M.			
2. Fuel Burned									
Oil									
Mixture of Oil and Coal			X		X	X	X	X	X
(7:30 A.M. to 9:15 A.M.)		X							
Oil only from 9:15 A.M. on until shut down		X							
3. Electrostatic Precipitator in Operation 7:30 to 9:00)		X			—	—	—	—	—
4. Plant Records									
CO_2 Recorder Not Operating		X	OK		—	— None Used —			
Smoke Density Recorder Not Operating		X	OK		OK	OK	OK	OK	OK
5. Air Supply									
Forced Draft		X	X		X	X	X	X	X
Induced Draft			X		X	X	X	X	X
Natural Draft		X							
6. Plant Located Upwind on Major Axis of Fallout Pattern		—Yes—			No	No	No	No	No
7. Plant Located at Indicated Number of Stack Heights from Center of Fallout Pattern		—10—			10	10	10	10	10
8. Fallout Observed Upwind of Plant		No			Yes	Yes	Yes	Yes	Yes
9. Top of Stacks in Clouds and Not Visible for Smoke Observations		Yes			Yes	Yes	Yes	Yes	Yes
10. Plant Condition									
Breeching in Need of Repair — Interferes with Natural Draft		X							
11. Source implicated if the soot was at least in part of coal origin		X							

All of these units, which are maintained in good condition, are operated with forced and induced draft. They are not provided with CO_2 indicators but they are equipped with smoke density recorders, stream flow-air flow recorders, and flue gas and steam temperature recorders. Examination of these records failed to reveal information that would suggest the possibility of maloperation of the units during the fallout period.

The Boston Edison plant, as is the M.T.A. plant, is located at approximately its probable fallout distance from the center of the heavy fallout; it is physically closer but its stacks are much lower. However, it is in a more northerly direction therefrom than that direction from which the prevailing winds issued. In addition, soot-fallout was located on the roof of the plant and on the ground approximately 200 yards upwind of the Boston Edison plant stacks.

Interpretation of the above facts and comparison of the implications thereof with interpretations made from the M.T.A. data supported the premise that the M.T.A. was more likely the probable source of the soot and justified further specific studies centered around the M.T.A. plant.

These facts strongly indicated the advisability of a detailed study and analyses of M.T.A.-Unit No. 22's records to determine its combustion efficiency during the subject period, the ability of this unit to form an amount of soot necessary to cause the fallout nuisance, and the probability thereof. These aspects are discussed in the next sections of this report.

VII. CERTAIN ASPECTS OF FUEL COMBUSTION

A. *Factors Affecting Combustions*

1. *Temperature, Time and Turbulence*

It is basic to combustion that sufficient temperature in the combustion chamber must be maintained to permit the necessary chemical reactions between oxygen and the constituents of the fuel to take place. Further, an adequate time in the presence of these temperatures must be permitted to permit the reaction to go to completion. Third, sufficient turbulence must occur to provide for intimate mixing of oxygen, carbon and hydrocarbon molecules. If any one of these three factors is absent, incomplete combustion will occur.

2. *Excess Air*

In order to assure that adequate oxygen is supplied for combustion, it is necessary to provide air (oxygen) in excess of that theoretically required to attain complete combustion. An approximate value for excess air is usually taken as 30 to 50 per cent in excess of that theoretically required; the necessary amount is affected by many factors, including the design of the furnace and the type of fuel.

3. *Pre-heating*

In the combustion of oil, particularly oil of the heavier grades, it is necessary to provide for pre-heating of the oil to enable proper atomization, i.e. the breaking up of the oil, at the point of injection into the combustion chamber, into droplets approaching, as nearly as possible, molecular size. Failure to provide pre-heating will result in larger droplets of oil being injected into the combustion chamber, thus requiring a longer period of time for complete combustion. If the furnace does not provide this time, then incomplete combustion will occur.

4. *Coal Grinding*

In the firing of pulverized coal, it is necessary to grind the coal to a degree of fineness sufficient to permit rapid oxidation of the combustible material. The degree of fineness normally required is that at which approximately 75 per cent of the pulverized coal will pass a 200 mesh screen. Failure to properly pulverize the coal will result in a greater time being required for complete combustion, as in the case of improper atomization of oil. It should be noted here that the combustion of pulverized coal, while very similar to the combustion of oil, is not identical, since the rate of combustion is different and the normal excess air requirement is also different.

B. *Products of Complete Combustion*

Fossil fuels, such as coal, oil, and gas all contain hydrocarbons. Oil and gas have hydrocarbons as their major constituent with traces of impurities, the percentage of which varies, particularly in the case of oil, with the type and source of fuel. Coal contains a high percentage of free carbon with the balance of the carbon content being volatile hydrocarbons. In addition, coal contains a larger percentage of impurities than does oil or gas.

The complete oxidation of carbon results in the formation of carbon dioxide. The complete oxidation of hydrogen results in water or water vapor. The oxidation of sulphur normally present as an impurity in coal and oil results in the formation of sulphur dioxide and sulphur trioxide. The inert ash and water originally present in the fuel normally pass through the combustion process unchanged except, in some instances, as to physical state, although some of the constituents of the ash, such as ferric oxide, may be further oxidized to a higher oxide, such as magnetite. Since air is used as the source of oxygen, the inert constituents of air (nitrogen and trace elements) are passed through the combustion process largely unchanged except for the formation of small quantities of oxides of nitrogen.

Therefore, the products of complete combustion are carbon dioxide, water vapor, inert ash or "fly ash" (which is not really a product of combustion but rather the release of impurities originally present in the fuel) and small quantities of the oxides of sulphur and nitrogen. In the case of the burning of pulverized coal, the fly ash will be released in sufficient quantities to require removal from the flue gas prior to its release to the atmosphere, whereas in the combustion of oil the fly ash, representing a very small proportion of the oil in its original state, will not be present in sufficient quantities to normally require removal.

C. *Products of Incomplete Combustion*

During incomplete combustion the reactions described above do not all go to completion. Most important is the failure to completely convert carbon to carbon dioxide. This results in some carbon monoxide being present and possibly in the presence of some elemental carbon either from carbon atoms present in volatized hydrocarbon molecules or as pieces of carbon originally present as particles of coal. In addition, the characteristics of the fly ash may differ because of failure to further oxidize some components of the ash and/or because of the failure to change their physical appearance due to the possible presence of lower temperatures than might occur in complete combustion.

D. *Theory of Soot Formation*

1. *What is Soot?*

Soot is carbon. It is composed of atoms of carbon which may be fused into larger particles or agglomerated into chains of carbon atoms, which may further agglomerate into clumps or flakes. Pieces of carbon, originally present as the fixed carbon in coal, which may be emitted from a coal-fired furnace during incomplete combustion are not properly termed "soot" but might be better described as "fly carbon" (similar to "fly ash").

2. *How is Soot Formed?*

Soot is formed, after the vaporization of hydrocarbons present in fuels and the subsequent disassociation of hydrogen and carbons atoms from hydrocarbon molecules, by the failure to promote the oxidation reaction between the carbon and the oxygen. This failure may occur because of lack of time necessary for the reaction (insufficient furnace volume resulting from poor design or excess firing rate), insufficient temperature to cause the reaction (caused by "cold spots" or contact with cool surfaces such as boiler tubes or furnace walls), by lack of sufficient turbulence to permit adequate mixing of carbon and oxygen atoms, or simply by lack of sufficient oxygen in the furnace resulting from insufficient excess air. When soot is formed in the furnace, it usually remains as soot because it does not stay in the high temperature portion of the furnace long enough for the carbon to become oxidized.

The effects of soot formation are: —

1. reduction in overall plant efficiency due to the failure to realize the heat from the exothermic reaction between carbon and oxygen;
2. the sooting of boiler tubes and other heat transfer surfaces with resultant reduction in heat transfer coefficient;
3. the deposit of soot in pockets throughout the breeching;
4. the reduction in precipitator efficiency (on an overall weight

basis) since carbon, being an excellent conductor, is difficult to collect in an electrostatic precipitator; and obviously

5. the discharge of soot to the ambient air.

VIII. EFFICIENCY OF COMBUSTION AND THE PRODUCTION OF SOOT BY THE SOUTH BOSTON STATION OF THE MTA

A. *Preliminary Investigation*

The efficiency of steam-generating units of the Boston Edison Company and of the Metropolitan Transit Authority at their South Boston Stations was investigated for the morning of May 13. A preliminary investigation of records failed to indicate the probability of significant periods of mal-operation of any units of the Boston Edison Company during the period of interest. However, certain records of the MTA, the general condition of the plant, and the weight of other evidence which tended to indicate that the MTA plant was a probable source of much of the soot, caused the Division to inquire further into the operation of steam generating equipment at this station.

B. *Fundamentals of Further Investigation into Operation at MTA*

For purposes of orientation, certain facts regarding the plants' operation on the morning of May 13, will be restated here. Boilers No. 21 and 24 were not operating during the morning; boiler 21 was being repaired and boiler 24 went off the line at 7:15 A.M. Boilers 22 and 23 were brought up to load commencing about 7:00 A.M. and reached steady load about 8:00 A.M. Boiler No. 22 was fueled initially by oil, with pulverized coal being added, according to testimony, at about 7:30 A.M. and continued to about 9:00 A.M., during which period about 10,700 pounds of coal were said to have been consumed. After 9:00 A.M. the unit was oil-fired for the remainder of the day. It remained in constant use, with varying load, until after 6:00 P.M. Boiler No. 23 was oil-fired until 9:10 A.M., when it was taken off the line. It was subsequently lit off again briefly (5-10 minutes) at about 9:30, shut down, and then put back on line at 10:15 A.M.

The Department in its investigation considered the following data available for the plant:

Fuel Consumption: Oil consumption for the plant is available from a continuous record of the amount of oil pumped to and in storage at the plant. Certain estimates must be made to proportion this total consumption between the two operating units.

Total coal consumption, for the period 7:30 - 9:00 A.M., is reported to have been 10,700 pounds, all of which was fed to boiler No. 22.

Heating Value of Fuels: The White Fuel Company supplied data on the heat value of the fuel oil. This value, 18,380 BTU (British Thermal Units) per pound of oil, is the so-called "higher heating value", and does not take into account the vaporization and subsequent heating of water formed by the combustion of hydrogen. If this inescapable loss is charged against the fuel, the resultant "lower heating value" is 17,400 BTU per pound, or, when converted to BTU per gallon at the temperature of oil for which the service tank is calibrated, 140,000 BTU per gallon.

A 1958 analysis by the MTA of the coal revealed a "higher heating value" of 14,100 BTU per pound; the "lower heating value" is estimated to be 13,000 BTU per pound.

The use of lower heating values, as was done in the remainder of this section, gives thermal efficiencies of properly operated boilers in the vicinity of 80%.

Steam Production and Heat Output (HO): There are available continuous records of steam production and steam temperature for each operating unit. Steam pressure was stated as 305 psis, while boiler feedwater temperature was said to be 245°F. The charts variously indicate steam temperatures of about 500 - 600°F.

Other Unit Records: There are available for boiler No. 23 continuous records of carbon dioxide (CO_2) in the flue gas and a continuous smoke recorder chart, for the period of interest. For boiler No. 22 there was no operable smoke recorder on May 12 or 13, and the CO_2 recorder was inoperative over the period 8:00 - 10:00 A.M., May 13.

Continuous flue gas temperature records are kept and the Bailey Boiler Meter charts show steam flow and relative air flow curves, for both boilers.

Certain Assumptions:

On the basis of the CO_2 and smoke density indicator records, it was assumed that Boiler No. 23 (which was fired with oil) was operating properly and efficiently. During the entire period 8:00 - 9:30 A.M., thermal efficiencies for the boiler units were estimated as follows (based on lower heating values):

Boiler No. 23 — 80% (assumed to be operating (efficiently)

Boiler No. 22 — 8:00 - 8:30 — 75% (lower than No. 23 because the unit was fired with a combination of coal and oil, but not very low because no sootfall was observed)
8:30 - 9:30 — unknown

C. *Rate of Coal Consumption at MTA Plant*

1. On the basis of plant records and absence of sootfall it was assumed that normal thermal efficiency was achieved during the period 8:00 - 8:30 A.M. An estimate was then made of the consumption of coal over that period, as follows:

a. Boiler No. 23
From records of steam production and temperature, the equivalent heat output was calculated. A thermal efficiency of 80% was assumed to permit estimation of required heat input. This required heat input was equivalent to 660 gallons of oil.

b. Boiler No. 22
From records of steam production and temperature, the equivalent heat output was calculated. A thermal efficiency of 75% was assumed to permit estimation of required heat input. Since 940 gallons of oil were used in the plant in this period, of which 660 gallons were used in boiler No. 23, 280 gallons were used in boiler No. 22. The remainder of the required heat input must have been derived from coal. Thus it is estimated that 3200 pounds of coal were consumed during this period.

2. It was assumed that the rate of coal feed was the same over the next half-hour (viz. 8:30 - 9:00 A.M.)

D. *Overall Thermal Efficiency of MTA Plant, May 13, 1960.*

	Time Interval 8:00 - 8:30	8:30 - 9:30	8:00 - 9:30
Steam Production (pounds)	124,000	197,000	321,000
Heat Output (million BTU)	135	212	347
Oil Consumption (gallons)	940	2310	3250
Coal Consumption (pounds) (See Section C)	3200	3200	6400
Heat Input (million BTU)	170	365	538
Efficiency (Thermal)	79%	58%	65%

E. *Thermal Efficiency of MTA Boilers Nos. 22 and 23, 8:30 - 9:30 A.M.*

1. Boiler No. 23

From records of steam production and temperature, the equivalent heat output from this boiler was calculated. A thermal efficiency of 80% was assumed to permit estimation of required heat input. This required heat input was determined to be equivalent to 830 gallons of oil.

2. Boiler No. 22

From records of steam production and temperature, the equivalent heat output from this boiler was colculated. The actual heat input was derived from the estimated fuel input to the boiler; 3200 pounds of coal (Sect. C-2) and 1480 gallons of oil (Station use minus consumption by boiler No. 23). The thermal efficiency of the boiler during this period (the ratio of heat output to heat input) was calculated to be 48%.

F. *Estimate of Amount of Soot-Produced and Released by Boiler No. 22, MTA, 8:30 - 9:30 A.M.*

1. Soot Produced

a. The consumption of fuel by and the thermal efficiency of this boiler during this period have been estimated as
    1. Oil Consumption — 1480 gal. = 11,800 pounds
    2. Coal Consumption — 3200 lbs.
    3. Thermal Efficiency — 48% (say 50%)

b. At normal thermal efficiency, assumed as 75% when burning coal and oil together, very little carbon is not converted to CO or CO_2, i.e., very little soot is formed.

c. For purpose of initial calculation, it was assumed that the reduction from normal to actual thermal efficiency was entirely due to the formation of soot; i.e., the loss of the heat value of carbon. This permits calculation to show that about 3500 pounds of soot may have been formed in the furnace of boiler No. 22, from about 8:30 - 9:30 A.M.

2. Soot Released to the Ambient Air

a. If it is presumed that 70% of the soot formed was retained in the breeching, precipitator, stack, etc., about 1,000 pounds would have been discharged.

3. Discussion of Findings

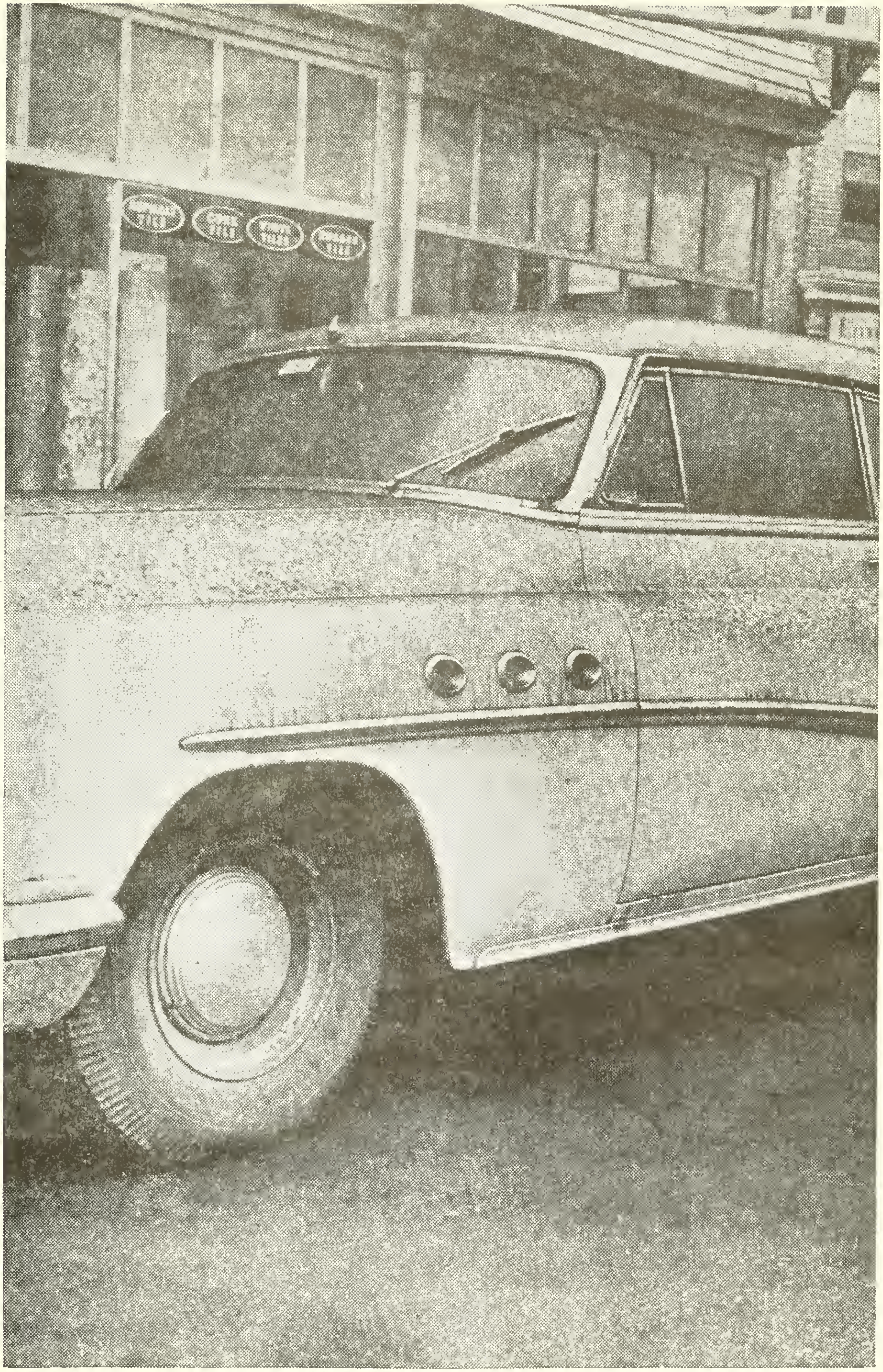
a. These figures of soot production and discharge were arrived at through the use of a series of estimates, assumptions, and calculations to demonstrate that a period of poor combustion probably did exist, between the hours of 8:30 and 9:30 A.M., in boiler unit No. 22 of the MTA, and to show how much soot was probably formed. Reasonable variations can be made in the estimates and assumptions which would decrease the calculated inefficiency and soot production, but not to the extent that they would cease to be significant. It can certainly be argued that carbon monoxide may have been formed thus reducing the estimated quantity of carbon soot formed. Some of the heating loss may have been due to failure to burn fixed carbon in the coal. On the other hand, the estimated removal efficiency may be high. In summary, it would appear certain that at least several hundred pounds of soot were released to the ambient air from the MTA power plant during the period 8:30 A.M. to 9:30 A.M.

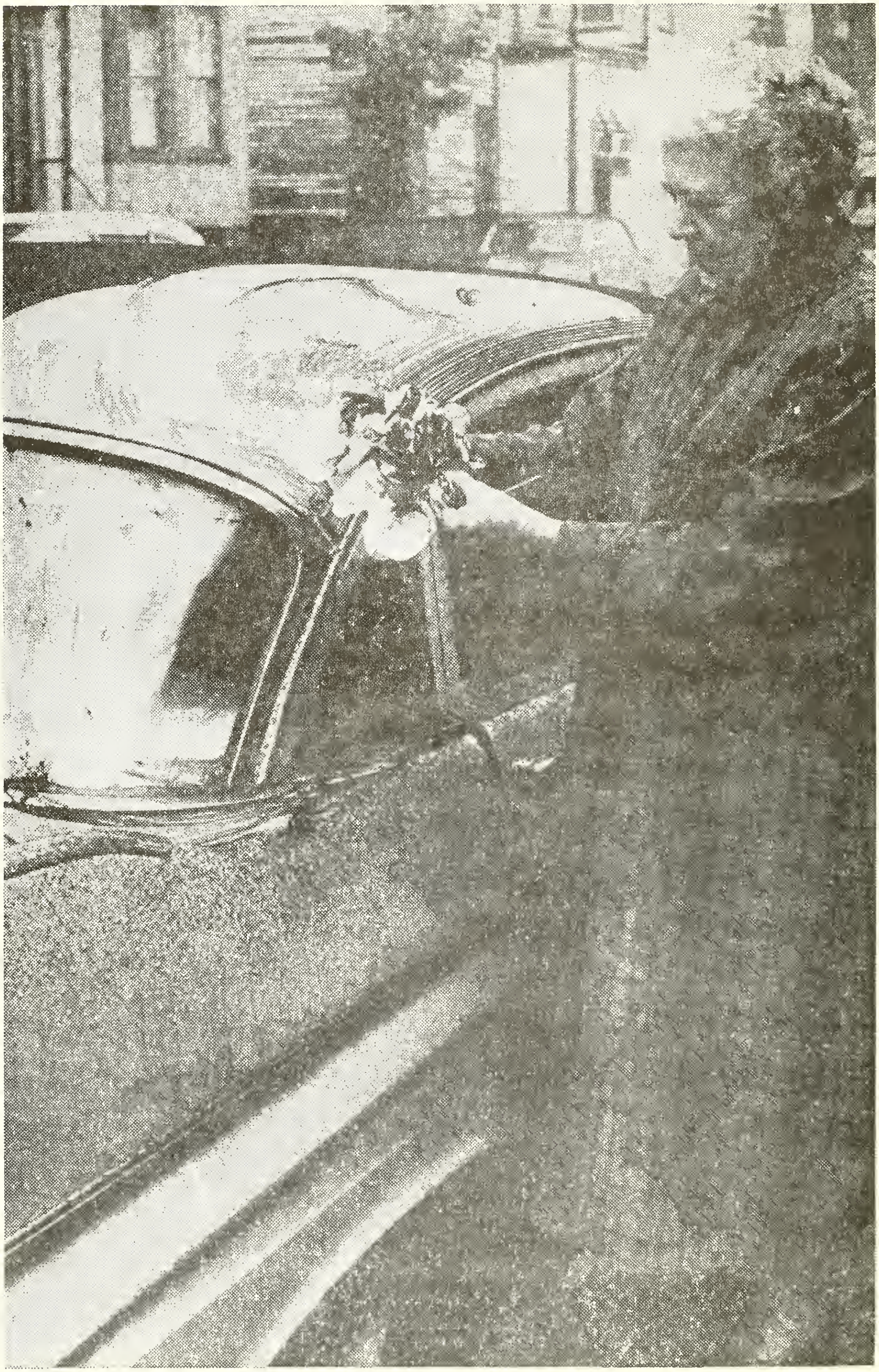
ACKNOWLEDGEMENTS

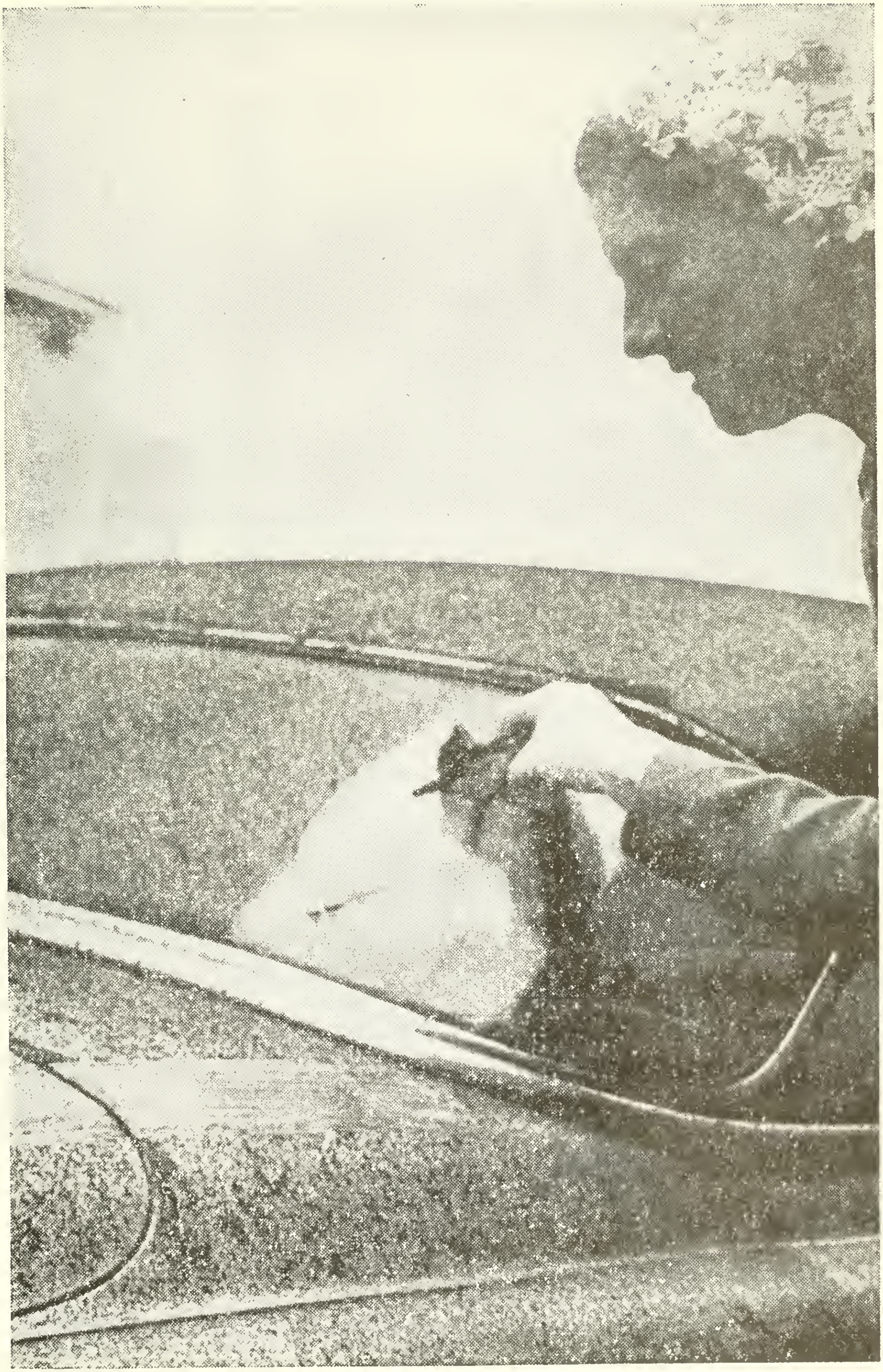
The Division of Sanitary Engineering of the Department of Public Health investigated this matter and prepared this report. The Division's engineers were assisted in their investigations and studies by personnel of the Smoke Division and by Mr. Leonard C. Mandell, P.E., acting in the capacity of consultant.

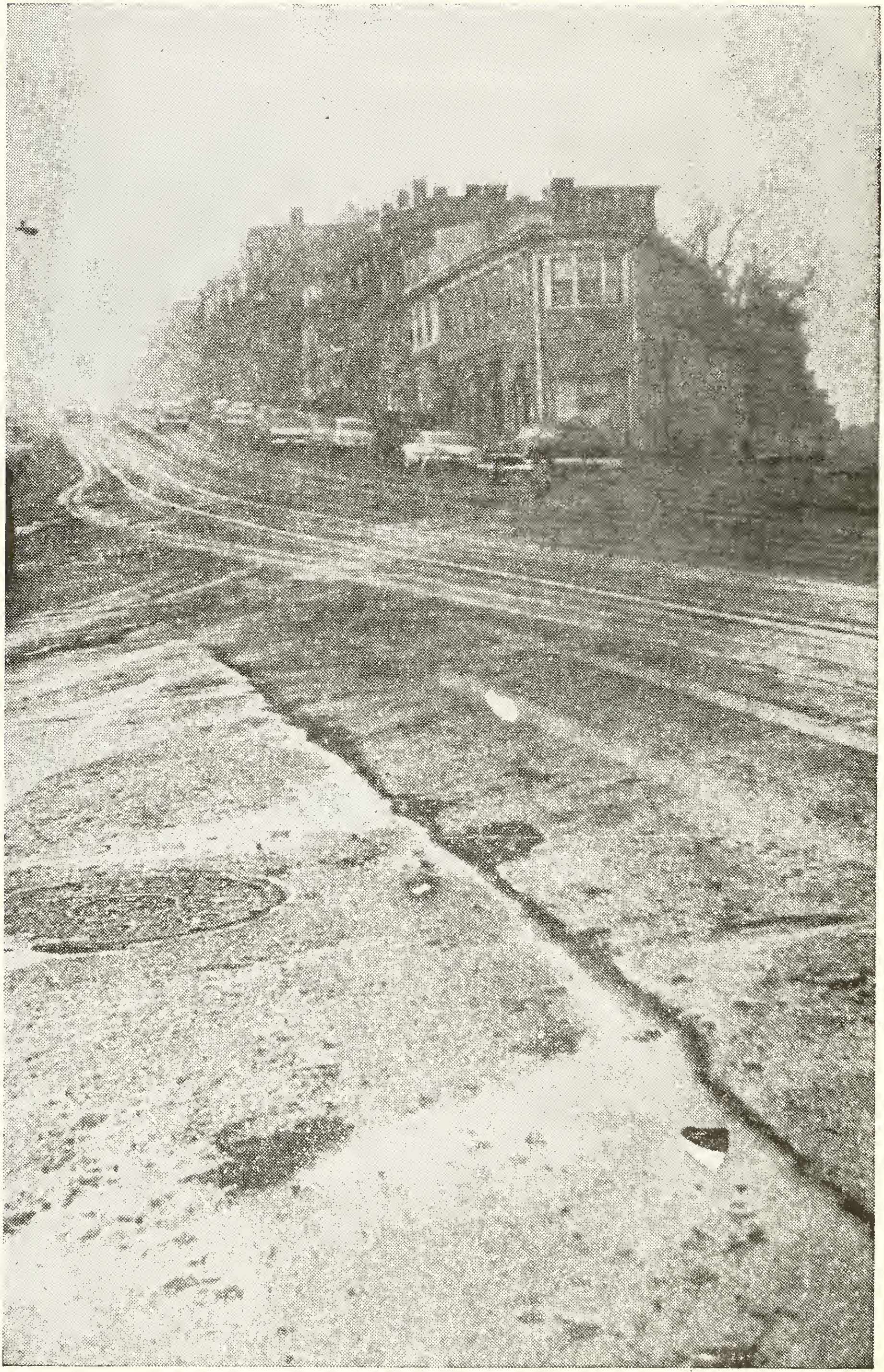
Mr. Oscar Tenenbaum, Chief Forecaster of the U.S. Weather Bureau, provided certain technical information and data and assisted in matters of meteorology. Officials and other personnel of all plants contacted willingly cooperated in the investigation.

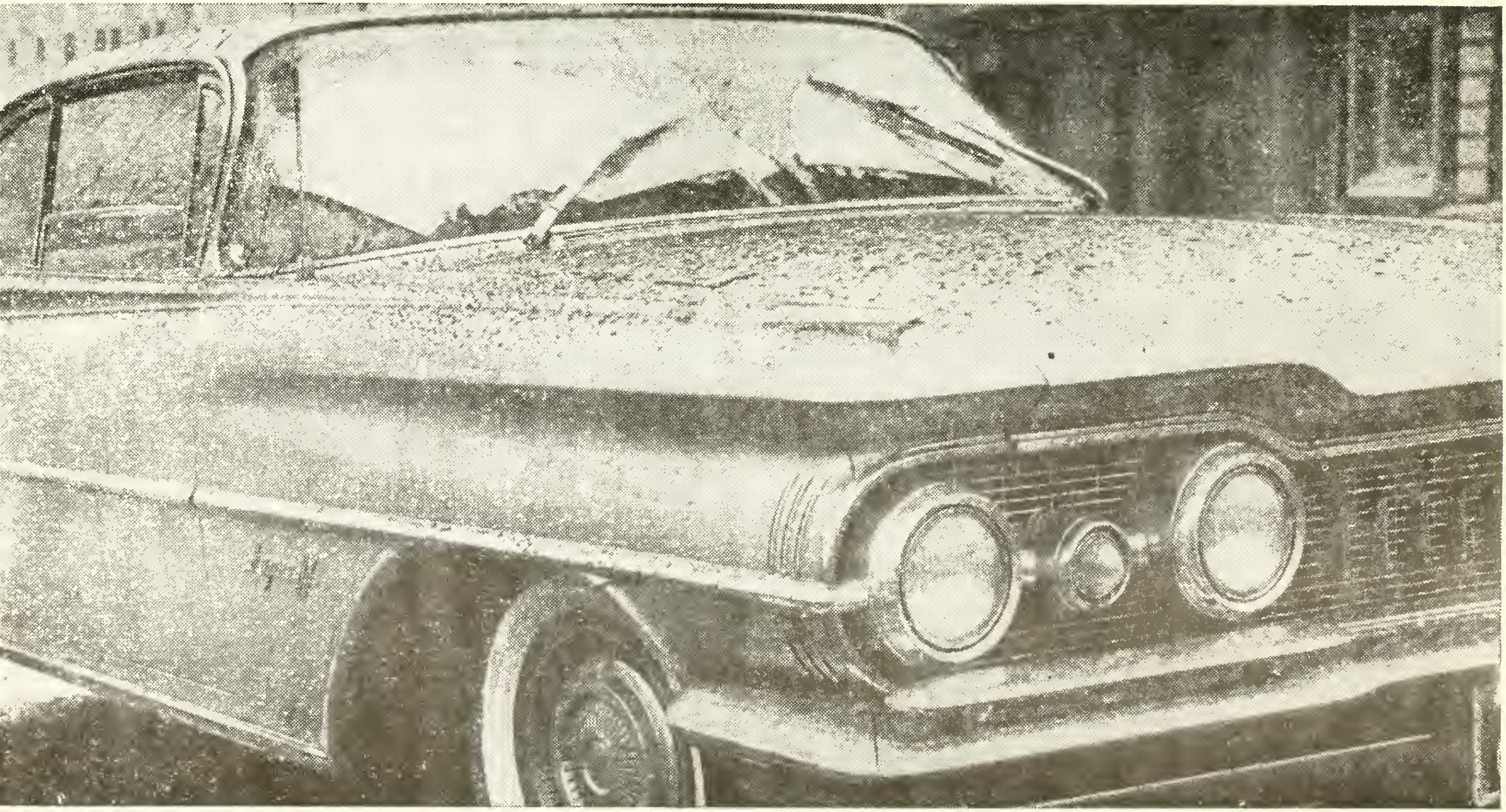
Certain other governmental agencies, private institutions, industrial concerns, and industrial organizations were contacted for specific information and data. The Department is grateful to all for the assistance rendered and the cooperation extended to it.











The Commonwealth of Massachusetts

It is palpable to this Committee that the administrative machinery under which the Division of Sanitary Engineering, Smoke Inspection Division, is forced to work is grossly inadequate.

There is no doubt that the proponents of the legislation which incepted the Division of Smoke Inspection in 1910 exercised genuine foresight. The tremendous technological advancement that has occurred and the fantastic growth of our industries have wrought changes that have, in great measure, resulted in new sources of atmospheric pollution.

The information gathered in the instant case has indicated to this Committee that air pollution (the instant case being only one type of air pollution) is a problem of tremendous magnitude. It is increasing, almost in an unbridled manner. The number of different sources contributing to this problem is not easily calculable, since much of it emanates from automobiles and home heating units.

The part played by the weather conditions — which are not within the control of man — is of paramount importance.

It appears that the Department of Public Health and the local communities are not sufficiently equipped to meet and overcome this general problem of air pollution; further, the extent to which it has become a problem and the damage it may and can do is not fully comprehended either by officials or by the public. The public must be educated to the inherent dangers. The agencies who can meet, control and overcome the challenge need funds and skilled employees.

This Committee feels that the enactment of the legislation which is proposed in this report and which is based, in great part, on H-45 presently before the Committee on Ways and Means on the side of the Senate would be a giant step in the proper direction.

The only certain method of preventing trouble is to reduce air pollution as much as possible before we are faced with a catastrophe. The agency needs more money to do its work. Public safety demands immediate positive action.

Respectfully submitted,

SENATOR JOHN E. POWERS, *Chairman,*
of Suffolk.
SENATOR JAMES W. HENNIGAN, JR.
of Suffolk.
SENATOR FRED LAMSON,
of Middlesex.
SENATOR MICHAEL LoPRESTI,
of Suffolk.

PROPOSED LEGISLATION

The Commonwealth of Massachusetts

In the Year One Thousand Nine Hundred and Sixty.

AN ACT RELATIVE TO CONTROL OF AIR POLLUTION IN THE CITY OF BOSTON AND VICINITY.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same, as follows:

SECTION 1. Chapter 111 of the General Laws is hereby amended by adding after section 142A, inserted by section 3 of chapter 672 of the acts of 1954 the following two sections: —

Section 142B. There is hereby established a metropolitan air pollution control district, to consist of the territory and waters comprised within the cities and towns of Arlington, Belmont, Boston, Braintree, Brookline, Cambridge, Canton, Chelsea, Dedham, Everett, Lynn, Malden, Medford, Melrose, Millis, Milton, Needham, Newton, Peabody, Quincy, Revere, Saugus, Somerville, Stoneham, Wakefield, Waltham, Watertown, Weymouth, Winchester, Winthrop and Woburn, and such other cities and towns as may from time to time make application to the department for admission to the said district and are thereupon accepted by vote of the department; provided, that such city or town and a city or town of the district as it exists at the time of application shall be at least in part contiguous.

It shall be the duty of the department to control pollution of the atmosphere within the metropolitan air pollution control district. In the exercise of its duty the department may from time to time, after notice to all persons interested and a public hearing, describe and establish, and may amend or repeal rules and regulations to prevent pollution or undue contamination of the atmosphere within the metropolitan air pollution control district. Said rules and regulations after being so prescribed and established shall have the force of law. The rules and regulations shall become effective upon filing with the state secretary, unless a later date is specified by the department, and such filing shall be prima facie evidence of compliance with all regulation-making requirements imposed by law.

Personnel of the department in the performance of their duties under this section may enter and inspect any property premise or place and stop, detain and inspect any motor vehicle for the purpose of investigating either an actual or suspected source of air pollution or air contamination or ascertaining compliance or non-compliance with any code, rule or regulation promulgated under this section. Any information relating to secret processes, or methods of manufacture, or production obtained in the course of the inspection or investigation shall be kept confidential upon request.

This section shall not operate to abrogate any of the powers and duties, as defined by general or special law, of any agency or political subdivision of the commonwealth.

The department shall have power to order any person, corporation or political subdivision having control of an air contamination source, other than an employee, to stop or abate violations of the provisions of any rules and regulations adopted pursuant to this section or of any rules and regulations adopted under provisions of Section 142A, Chapter 111.

Any person, corporation or political subdivision violating any order of the department shall be guilty of a misdemeanor, and may be punished by a fine of not less than fifty nor more than one hundred dollars for the first offence and not less than two hundred nor more than five hundred dollars for every succeeding offence.

For the purpose of this paragraph each subsequent day or part thereof of violation of such an order, while such violation may be either continuous or intermittent, shall be construed as a separate and succeeding offence. Violation of any order of the department, while such order is not the first issued within the calendar year against the same person, corporation or political subdivision for a like violation from the same air contamination source of a rule or regulation adopted under this section, shall be construed as a separate and succeeding offence. The superior court sitting in equity, on petition of the department or any person authorized by the department shall have jurisdiction to restrain violations of any rules or regulations adopted pursuant to this section during the prosecution of any proceeding at law for the enforcement of any order of the department.

Nothing in this section or in any rules or regulations adopted hereunder shall be construed as relieving, under any circumstances, any person, corporation or political subdivision from responsibility or liability for any damages which may occur or for civil or criminal proceedings arising out of or as a result of any action of said person, corporation or political subdivision, regardless of any action of the department, and persons other than the department shall not acquire actionable rights by virtue of this article.

The department in order to properly discharge its duties under this section shall maintain and operate such air sampling stations and devices; make or perform such routine and special examinations, inspections, observations, determinations, laboratory analyses, and surveys; maintain such records; and perform such other acts as it may deem necessary to conduct an adequate air pollution control program within the metropolitan air pollution control district.

The department shall request that funds in addition to its annual appropriation be appropriated by the general court for payment of the proportionate cost of its activities in the discharge of its duties under the provisions of this section. A separate accounting of such funds shall be maintained.

The commonwealth shall be reimbursed, as hereinafter provided, for all such appropriations made by the general court and expended by the department. The state treasurer shall issue his warrant requiring the assessors of the cities and towns of the metropolitan air pollution control district to assess a tax in the amount of the sums expended, and such amounts shall be collected and paid to the state treasurer as provided by section twenty of chapter fifty-nine of the General Laws; provided, that such city or town may in any year anticipate in whole or in part its assessment, and appropriate, raise and deposit the amount thereof with the state treasurer, and any sums so deposited shall be credited against such assessment. The appropriate share of each city or town shall be one-half of the amount of the sums expended times the ratio between the population of the city or town and the total population of the several cities and towns of the metropolitan air pollution control district plus one-half of the amount of the sums expended times the ratio between the assessed valuation of the city or town and the total assessed valuation of the several cities and towns of the district. The populations of the several cities and towns shall be the populations as determined by the last state or federal census, and the assessed valuations of the several cities and towns shall be the last preceding valuations made for purposes of apportioning the state tax.

The department may establish a schedule of reasonable fees for permits, if permits are required by rules and regulations established by the department under provisions of this section and receipts therefrom may be expended by the department without further appropriation.

Section 142C. Other air pollution control districts similar to that established by section 142B of chapter 111 may be formed upon approval of the department. Each such district shall be composed of at least two political subdivisions of the commonwealth, portions of the boundaries of some or all of which shall form a continuous boundary enclosing the entire area of the air pollution control district. The municipalities desirous of forming such a district shall jointly make application to the department, requesting the department to form the said district and to effect, in such manner and to such degree as the department may deem necessary and appropriate, the control of air pollution therein. The manner of making such application shall be as specified in applicable general or special laws. The powers, duties and rights of the department in the exercise of air pollution control in such districts and the manner in which funds shall be made available to it shall be as provided in the said section 142B of chapter 111.

Section 2. Upon the effective date of this act the division of smoke inspection, as established by chapter 352 of the acts of 1934 and transferred to the department of public health by chapter 672 of the acts of 1954 is abolished and all employees of the department of public health who are presently engaged in the enforcement of or are assigned to duties required by chapter six hundred and fifty-one of the acts of nineteen hundred and ten are assigned herewith to the division of sanitary engineering of said department, and may be further assigned to duties required by this act, at the discretion of the department. Passage of this act shall in no way operate to impair the civil service, retirement, seniority or any other rights of the afore-mentioned employees, and their continuity of service shall not be deemed to be interrupted within the meaning of either chapter thirty or chapter thirty-one of the General Laws.

Section 3. Chapter six hundred and fifty-one of the acts of nineteen hundred and ten, as amended, chapter one hundred and eighty-eight of the acts of nineteen hundred and thirty-six, chapter five hundred and forty-four of the acts of nineteen hundred and fifty, section six of chapter six hundred and seventy-two of the acts of nineteen hundred and fifty-four, and any other acts or portions of acts inconsistent with the provisions of this act are hereby repealed; provided, that such provisions of said chapter six hundred and fifty-one of the acts of nineteen hundred and ten as apply to the classification of stacks, the prohibition of smoke emissions, and the method of observation shall remain in force and effect and have the status of rules and regulations adopted pursuant to section one hundred and forty-two B of chapter one hundred and eleven of the General Laws, as inserted by section two of this act, until superseded by subsequent rules and regulations as may be adopted by the department of public health.

Section 4. Chapter 236 of the acts of nineteen hundred, Chapter 37 of the acts of nineteen hundred and twenty-one, and Chapter five hundred and twenty-six of the acts of nineteen hundred and forty-one, are repealed as of the first anniversary of the effective date of this act.

SECTION 5. This act shall take effect upon its passage.

APPENDIX B

CORRESPONDENCE WITH AGENCIES

MASSACHUSETTS HISTORICAL COMMISSION

COMMONWEALTH OF MASSACHUSETTS
Office of the Secretary of State

294 Washington Street
Boston, Massachusetts
02108
617-727-8470

MICHAEL JOSEPH CONNOLLY
Secretary of State

November 17, 1982

Mr. Dennis G. Tuttle
Stone and Webster Engineering Corporation
245 Summer Street
Boston, MA 02107

Re: Proposed Coal Conversion, Boston Edison New Boston Station

Dear Mr. Tuttle:

Thank you for your recent letter requesting information on archaeological and historic properties which may relate to the proposed coal conversion project at the New Boston Station in South Boston.

Staff of the Massachusetts Historical Commission have reviewed the Inventory of Historic Assets of the Commonwealth for this project. The review has revealed that no significant historic or archaeological properties have been recorded within the proposed project area. It is anticipated that the proposed coal conversion will not affect previously unidentified cultural resources, since the conversion will take place within the existing power station.

If you have any questions or require further assistance, please feel free to contact Brona Simon of MHC staff.

Sincerely,

Valerie Talmage

Valerie Talmage
State Archaeologist
Acting State Historic Preservation Officer
Massachusetts Historical Commission

VT/pg

Massachusetts
Natural Heritage
Program

January 7, 1983

D.G. Tuttle, Lead Environmental Engineer
Stone & Webster Engineering Corp.
254 Summer St.
Boston, MA 02107

Dear M . Tuttle:

Re: New Boston Station
Coal Conversion

As you requested, the Massachusetts Natural Heritage Program has reviewed an area within a two mile radius of the proposed coal conversion at New Boston Station. At this time, our data base does not contain records of rare plant or animal species populations, or unusual plant communities or aquatic habitats which would be adversely impacted by the coal conversion within this vicinity.

Please note that our inventory is continually expanding through ongoing research and fieldwork, so that further information on this site may become available in the future. Thank you for consulting us on this project.

Yours sincerely,

John Feingold
for Allison Sanders-Fleming
Environmental Review

ASF:phb

Department of Environmental Management 100 Cambridge Street, Boston, Mass. 02202 (617) 727-~~3188~~ 3160

MYSTIC & NEW BOSTON STATIONS

HISTORIC & NEW BOSTON STATIONS

APPENDIX C

AN EVALUATION OF SULFUR CONTENT FUEL FOR USE AT MYSTIC AND NEW BOSTON STATIONS

Prepared by

Environmental Research & Technology, Inc.

Document P-B318-200
October 1982

Prepared for
Boston Edison Company
Boston, Massachusetts 02199

An Evaluation of Sulfur Content Fuel for Use at Mystic and New Boston Stations

BOSTON
PUBLIC
LIBRARY

ENVIRONMENTAL RESEARCH & TECHNOLOGY, INC.
ATLANTA · CHICAGO · CONCORD, MA · FORT COLLINS, CO
HOUSTON · LOS ANGELES · PITTSBURGH · WASHINGTON DC

ACKNOWLEDGEMENTS

The ERT project team consisted of the following individuals:

Mr. Robert V. Bibbo - Project Manager
Mr. David M. Shea - Air Quality Modeling Task Manager
Mr. John McCutcheon - Air Quality Scientist
Mr. John Beebe - Computer Software Support

TABLE OF CONTENTS

Page

ACKNOWLEDGEMENTS iii

LIST OF ILLUSTRATIONS vii

LIST OF TABLES ix

1. STUDY OVERVIEW 1-1
    - 1.1 National Ambient Air Quality Standards and PSD Increments 1-3
2. SUMMARY AND CONCLUSION 2-1
3. A MODELING METHODOLOGY FOR ASSESSING AMBIENT SO_2 CONCENTRATIONS DUE TO COAL CONVERSION AT BOSTON EDISON's MYSTIC AND NEW BOSTON GENERATING STATIONS 3-1
4. COMPLIANCE ASSESSMENT 4-1
    - 4.1 24-Hour Average SO_2 Concentrations 4-2
    - 4.2 Complying Sulfur Content Assessment 4-7
    - 4.3 3-Hour Average SO_2 Concentrations 4-13
    - 4.4 Annual Average SO_2 Concentrations 4-15
5. PSD SO_2 INCREMENT ASSESSMENT 5-1
    - 5.1 3-Hour SO_2 Concentrations 5-2
    - 5.2 24-Hour SO_2 Concentrations 5-6
    - 5.3 Annual Average PSD Increment Consumption 5-11

APPENDIX A DESCRIPTION OF THE ISC MODEL

APPENDIX B DETERMINATION OF GEP STACK HEIGHT FOR BOSTON EDISON'S MYSTIC AND NEW BOSTON STATIONS

APPENDIX C WORST-CASE LOAD ASSESSMENT FOR MYSTIC AND NEW BOSTON STATIONS

APPENDIX D MAJOR POINT SOURCE INVENTORY

APPENDIX E COORDINATES OF RECEPTOR LOCATIONS

LIST OF ILLUSTRATIONS

Figure		Page
1-1	Location of Boston Edison Plants in the Boston Area	1-2
1-2	Corporate Boundaries of Boston/Milton	1-7
3-1	Major Sources of Sulfur Dioxide Located within 20 km of the Edison Plants	3-4
3-2	Receptor Grid Employed in the ISC Modeling	3-13
5-1	Annual Average SO_2 PSD Increment Consumption	5-15

LIST OF TABLES

Table		Page
1-1	National Ambient Air Quality Standards and Prevention of Significant Deterioration Increments for Sulfur Dioxide	1-4
3-1	Major Background Sources of SO_2 Included in the Sequential Modeling	3-3
3-2	Baseline Emission Parameters for Boston Edison Stations	3-6
3-3	Boston Edison SO_2 Emssion Parameters for the Proposed Coal Fired Configuration at New Boston and Mystic Stations	3-8
3-4	ISC Model Options Used in the Analysis for Boston Edison Coal Conversion	3-16
3-5	Sulfur Dioxide Monitors Used in the Boston Edison Coal Conversion Study	3-18
4-1	Highest 24-Hour Average SO_2 Concentrations Predicted in the Primary PSD Baseline Area	4-3
4-2	Highest 24-Hour Average SO_2 Concentrations Predicted Outside the Primary PSD Baseline Area	4-4
4-3	Twenty-Five Highest 24-Hour Average Concentration Days Predicted by the ISC Model	4-6
4-4	Complying Sulfur Content Limitations for the Mystic Station	4-8
4-5	Complying Sulfur Content Limitations for the New Boston Station	4-9
4-6	Highest 24-Hour Average SO_2 Concentrations with Mystic and New Boston at Complying Sulfur Content Coal	4-11
4-7	Highest 3-Hour Average SO_2 Concentrations with Mystic and New Boston at Complying Sulfur Content Coal	4-14
4-8	Highest Annual Average SO_2 Concentrations Predicted in the Primary PSD Baseline Area	4-16

LIST OF TABLES (Cont.)

Table		Page
4-9	Highest Annual Average SO_2 Concentrations Predicted Outside the Primary PSD Baseline Area	4-17
5-1	Highest 3-Hour Average SO_2 PSD Increment Consumption in the Primary PSD Baseline Areas from Sources Modeled in this Study	5-3
5-2	Highest 3-Hour Average SO_2 PSD Increment Consumption in Perimeter PSD Baseline Areas from Sources Modeled in this Study	5-4
5-3	Highest 24-Hour Average SO_2 PSD Increment Consumption in Primary PSD Baseline Areas from Sources Modeled in this Study	5-7
5-4	Highest 24-Hour Average SO_2 PSD Increment Consumption in Perimeter PSD Baseline Areas from Sources Modeled in this Study	5-8
5-5	Highest 24-Hour Average SO_2 PSD Increment Consumption Resulting from Interaction of Mystic and New Boston with Natick Paperboard	5-10
5-6	Highest Annual Average PSD Increment Consumption in Primary PSD Baseline Areas from Sources Modeled in this Study	5-12
5-7	Highest Annual Average SO_2 PSD Increment Consumption in Perimeter PSD Baseline Areas from Sources Modeled in this Study	5-13

1. STUDY OVERVIEW

This report, prepared by Environmental Research & Technology, Inc. (ERT) for Boston Edison Company, presents and documents the results of a detailed ambient SO_2 air quality assessment for a proposal to convert the Mystic and New Boston Generating Stations to coal. Both generating stations are located within the Metropolitan Boston Air Quality Control Region (MBAQCR) as shown in Figure 1-1. The report contains all the necessary technical information and data to support a revised Massachusetts State Implementation Plan (SIP) increasing SO_2 emission limitations in order to allow coal firing at each station.

The Mystic Generating Station (984 net Mw), in Everett, Massachusetts consists of four oil-fired units of which three are candidates for conversion. Each Mystic candidate, Mystic Unit 4 (135 net Mw), Mystic Unit 5 (135 net Mw), and Mystic Unit 6 (149 net Mw) is currently fired on conforming 1.0% sulfur content residual oil. The fourth Mystic unit, Unit 7 (565 net Mw) is fired on 2.2% sulfur content oil and natural gas when available but is not a candidate for coal conversion. The New Boston Generating Station (700 net Mw) in South Boston, Massachusetts, consists of two units fired on conforming 1.0% sulfur content oil. Both New Boston Unit 1 (350 net Mw) and New Boston Unit 2 (350 net Mw) are candidates for conversion to coal.

Although a specific coal supply has not been identified, Boston Edison does expect that, if converted, each candidate unit will be fired on a coal with an effective average sulfur content that is greater than the coal equivalent of 1.0% sulfur content oil. Based on potential sources of coal, Boston Edison estimates that the 30-day average coal sulfur content will not exceed 1.5%. For purposes of this assessment, we have assumed that the coal sulfur content will be variable but will average out to 1.5% on a 30-day average which is roughly the equivalent of 2.2% sulfur content oil or 1.21# sulfur per million Btu. Thus, the current Massachusetts SIP must be revised before the conversion can be allowed.

The study was conducted in two parts. First, incremental and total changes in ambient SO_2 concentrations due to coal firing at

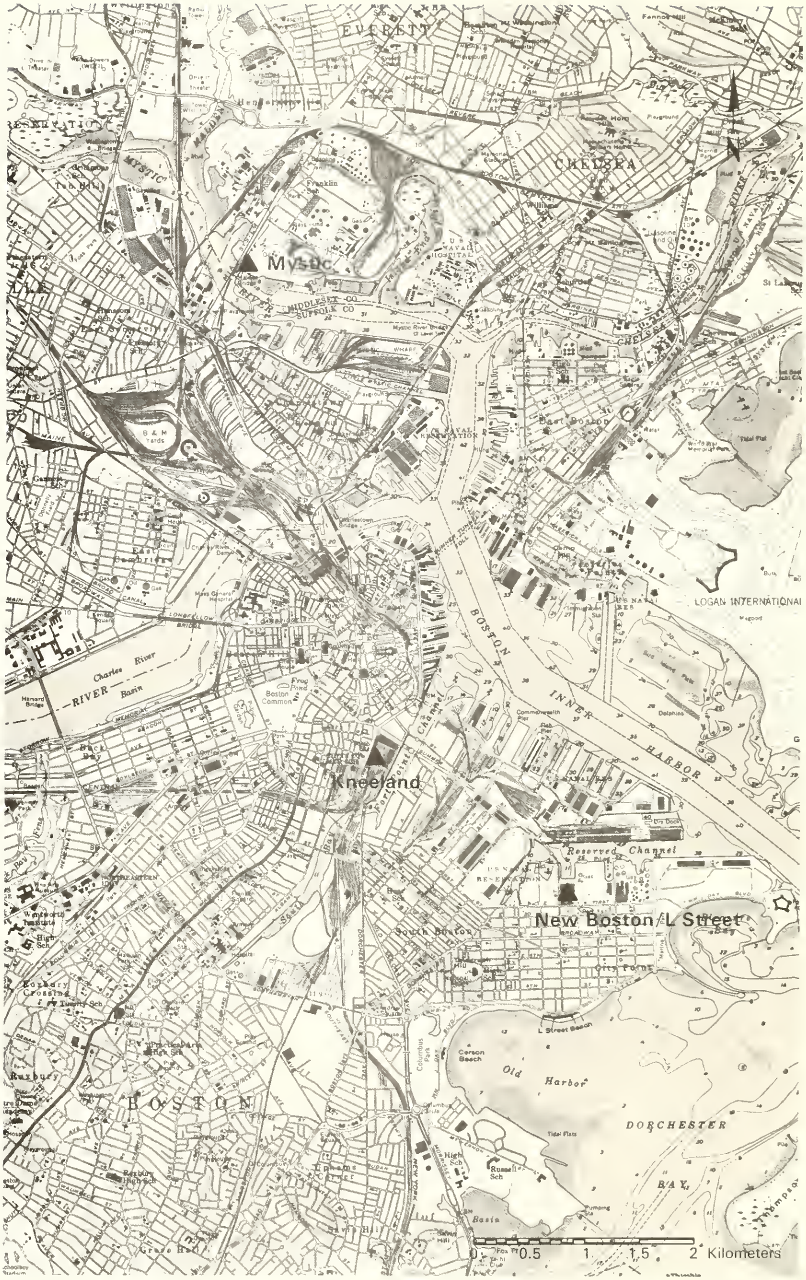


Figure 1-1 Location of Boston Edison Plants in the Boston Area

each candidate unit were predicted for the assumed average coal sulfur content of 1.5%. Then the resultant changes in ambient SO_2 concentrations were analyzed to determine a complying sulfur content for each candidate unit. A complying sulfur content is the highest coal sulfur content which allows for compliance with National Ambient Air Quality Standards (NAAQS). NAAQS include annual average as well as short-term standards, and since coal sulfur contents are variable, the complying fuel assessment in effect determines how much a coal sulfur content can deviate from the average without causing a violation of a short-term ambient standard. By agreement with the U.S. EPA and the Massachusetts DEQE, the complying sulfur content will be based on the primary 24-hour SO_2 standard and increment consumption will be assessed on the basis of average coal sulfur content.

1.1 National Ambient Air Quality Standards and PSD Increments

1.1.1 NAAQS and Section 107 Area Classifications

The NAAQS for SO_2, shown in Table 1-1, are legal limits that must be attained and then maintained throughout the country. They were established by the USEPA along with NAAQS for five other pollutants in accordance with the provisions of the 1970 Clean Air Act Amendments to protect the public health and welfare. The Massachusetts Department of Environmental Quality Engineering (DEQE) and the EPA ensure compliance with these standards by enforcement of the existing Masachusetts SIP. A revised SIP allowing coal-firing at the Mystic and New Boston Stations must also ensure maintenance of the ambient standards.

An area is designated as an attainment area if existing ambient concentrations are below the limits specified by NAAQS. If ambient concentrations are in violation of NAAQS limits, the area is classified as nonattainment. When ambient data to determine compliance with NAAQS are inadequate or non-existent, the area is designated as unclassified. An area is designated attainment, nonattainment, or unclassified by state air pollution control agencies

TABLE 1-1

NATIONAL AMBIENT AIR QUALITY STANDARDS AND PREVENTION OF SIGNIFICANT DETERIORATION INCREMENTS FOR SULFUR DIOXIDE

Standard	Averaging Time (μg/m^3)		
	Annual	24-Hour	3-Hour
NAAQS	80	365	1,300
PSD Increment	20	91	512

under provisions contained within Section 107 of the Clean Air Act. Such designated areas are commonly referred to as Section 107 areas. States have broad discretion as to how Section 107 areas can be designated. They can be as large as the entire state or as small as a city block. In Massachusetts, each city and town is a separate Section 107 area.

1.1.2 PSD Increments

PSD increments are not protective health or welfare based standards. They are best described as restrictive ambient constraints designed to prevent significant air quality deterioration of clean air. PSD increments apply in a designated Section 107 attainment area if the PSD baseline date has already been triggered for that area.

The PSD baseline date for an attaining 107 area can be triggered in one of two ways:

(1) The first completed PSD application for the 107 area has been filed.

(2) The 107 area is significantly impacted by allowable emissions associated with a completed PSD permit application in another Section 107 area.

Based on information provided by the U.S. EPA, the following cities and towns within the MBAQCR are triggered PSD baseline areas.

- Boston
- Milton
- Wellesley
- Natick

At EPA and DEQE's request, PSD increment consumption was also calculated in triggered PSD baseline towns of Methuen, N. Andover and Lawrence, Massachusetts. These towns are located in the Merrimack Valley Air Quality Control Region (MVAQCR).

PSD increment consumption was assessed only in the above-listed triggered baseline (Section 107) areas. A portion of the triggered baseline areas within the MBAQCR (Boston & Milton) are shown in Figure 1-2. PSD increment consuming sources located within the MBAQCR are also shown on the map.

The PSD increments for SO_2 are shown with the NAAQS in Table 1-1. Increases in SO_2 emissions after the triggered baseline date and increases in SO_2 emissions from a major source which commenced construction after January 6, 1975 will consume SO_2 increment in a triggered baseline area. Increment consuming emission increases can fall within five general categories:

- New major source construction (PSD permit) provided that such construction was commenced after January 6, 1975
- Modifications to major existing facilities (PSD permit)
- SIP changes which relax existing emission limits for existing sources
- Boiler fuel conversions which are not considered a modification of a major existing source (exempted from a PSD Permit)
- Increases in actual emissions from existing minor and major sources, which do not require a SIP revision

In this study, all increment consuming SO_2 emission increases were identified and included in the analysis of increment consumption. For the candidate Mystic and New Boston units, SO_2 emission increases will occur if coal with an average sulfur content greater than the equivalent of 1.0% sulfur content oil is fired. Since 1.0% sulfur content oil is roughly equivalent to 0.7% sulfur content coal, SO_2 emission increases at the candidate units will occur if the average sulfur content of the coal to be fired exceeds 0.7%. Boston Edison's best estimate is that the average coal sulfur content will not exceed 1.5% if the candidate units are converted. Hence, increment consumption, due to coal firing at each unit, was based on the average SO_2 emission increase associated with the use of 1.5% sulfur content coal.

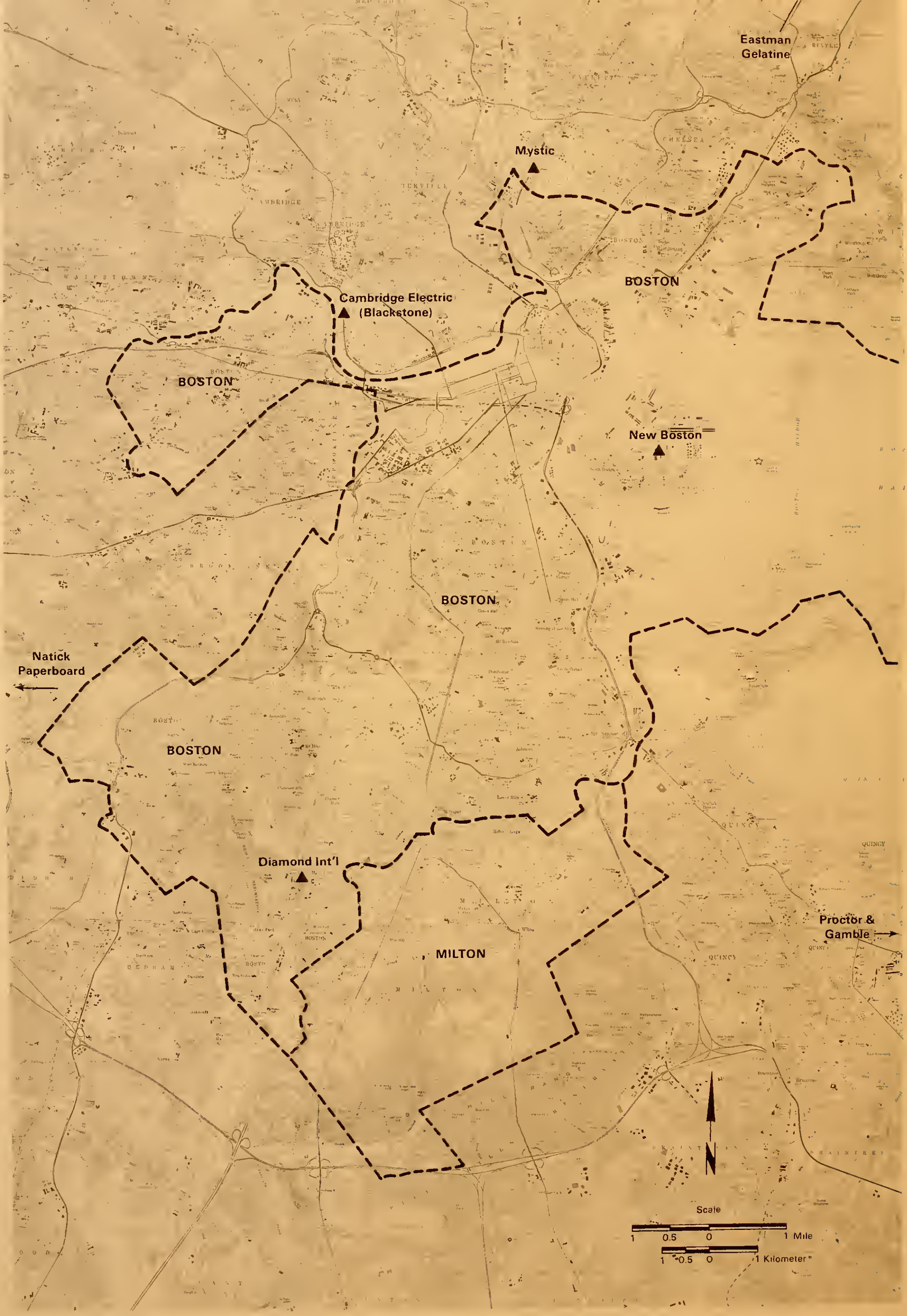


Figure 1-2 Corporate Boundaries of Boston/Milton
(Primary PSD Baseline Areas)

2. SUMMARY AND CONCLUSION

Overview

A comprehensive air quality modeling study was performed for Boston Edison's Mystic and New Boston Generating Stations. The study assessed the effect on ambient SO_2 concentrations of firing coal with an average sulfur content of 1.5% at five units which are candidates for conversion to coal. The candidate units are Mystic Units 4, 5, and 6 and New Boston Units 1 and 2. Boston Edison is currently allowed, under federally approved state air pollution control regulations, to fire 1.0% sulfur content residual oil in each of these units. Coal with an average sulfur content of 1.5% is equivalent to 2.2% sulfur content residual oil and thus the use of such a coal in each candidate unit would require a change to existing state air pollution regulations.

Summary of Pertinent Factors

1. Each candidate unit will be fired on a coal with an average sulfur content of 1.5%.
2. Mystic Unit 7 is not a candidate for coal conversion and Boston Edison will continue to fire this unit on conforming 2.2% sulfur content residual oil or natural gas on an interruptable contract basis.
3. The three existing 350 ft stacks venting oil-fired exhaust gases from Mystic Units 4, 5 and 6 will be replaced by one triple flue 500 ft GEP stack designed to vent the exhaust gases from all three units.
4. The four existing 250 ft stacks venting oil fired emissions from New Boston Units 1 and 2 will be replaced by one double flue 372 ft stack designed to vent the exhaust gases from both units.

Summary of Study Technique

1. The U.S. EPA Industrial Source Complex (ISC) model was used to simulate ambient SO_2 concentration.
2. The model simulations were performed for the coal-fired candidate units and other significant interacting major sources at 497 receptors over a five-year hour-by-hour meteorological record.
3. Background SO_2 concentrations were projected from hour-by-hour ambient SO_2 measurements which are coincident with the five-year meteorological record.
4. Total ambient SO_2 concentrations were determined by summing the modeled concentrations with the appropriate coincident background concentrations.
5. Model results and projections of total ambient SO_2 concentrations were analyzed for compliance with National Ambient Air Quality Standards and SO_2 PSD Increments.

Summary of Results

1. Projections of total ambient SO_2 concentrations indicate that each candidate unit can be fired on a coal with a 30-day average sulfur content of 1.5%. In fact, the results indicate that short-term and annual average standards will be maintained by a wide margin if the coal content were constantly maintained at a 1.5% level. This suggests that compliance with ambient standards could be achieved at sulfur contents higher than 1.5%.
2. Coal sulfur content can be significantly higher than 1.5% for 3-hour and 24-hour averaging periods. Appropriate analysis indicates that the primary 24-hour SO_2 and the secondary 3-hour SO_2 standard would be adequately protected if each candidate unit were fired on 4.6% sulfur content coal.

3. Average SO_2 emission increases due to coal firing at each candidate unit will not cause significant deterioration of air quality. Model results demonstrate that allowable SO_2 PSD increment thresholds will be maintained by wide margins. In fact, in some areas increment will be created or made more available (negative increment consumption).

Conclusion

Mystic Units 4, 5 and 6 and New Boston Units 1 and 2 could fire coal with a 30-day average sulfur content of 1.5% and maximum 24-hour average sulfur content of 4.6% without causing a violation of NAAQS or PSD increments. Since 4.6% is the highest 24-hour sulfur content average which ensures maintenance of both the primary 24-hour standard and secondary 3-hour standard it is referred to as the complying sulfur content.

3. A MODELING METHODOLOGY FOR ASSESSING AMBIENT SO_2 CONCENTRATIONS DUE TO COAL CONVERSION AT BOSTON EDISON'S MYSTIC AND NEW BOSTON GENERATING STATIONS

Overview

Air Quality modeling was performed for a 5-year meteorological data base (1977 through 1981) to assess compliance with NAAQS and PSD increments. Compliance with NAAQS was assessed on a full grid of 497 densely spaced receptors. Increment consumption was assessed on the same grid except that only the 166 receptors (a dense increment subgrid) located in the significantly affected PSD baseline area were considered. A modified version of EPA's Industrial Source Complex (ISC) model was used with appropriate options. Each candidate Mystic and New Boston Unit was modeled at a pre-determined "worst-case" load. All other major background sources were modeled at actual emissions. All existing PSD sources with increment consuming emissions were modeled at allowable emissions. Edison sources other than the candidate Mystic and New Boston units were modeled at actual maximum emissions.

A network average SO_2 background concentration was developed and added to modeled source impacts. The total was then compared to the NAAQS and a complying sulfur content coal was calculated for the Mystic and New Boston candidate units based on the primary 24-hour NAAQS. Maximum total 3-hour SO_2 concentrations were predicted and analyzed to ensure that the secondary 3-hour standard will be maintained at both average and complying coal sulfur contents. Ambient SO_2 concentrations due to all increment consuming sources were compared with the allowable PSD increment levels in all PSD triggered baseline areas. Increment consumption from the candidate Mystic and New Boston units was based on a 30-day average sulfur content whereas increment consumption due to other PSD sources with increment consuming emissions was based on the allowable emissions derived from a PSD permit or SIP revision.

Definitions

Major Background Source. Any existing major source within 10 km of the Mystic or New Boston Stations with annual average SO_2 emissions of 100 tons/year or greater or any existing major source between 10 km and 20 km of the Mystic or New Boston Stations with annual average emissions of 1000 tons/year or greater and the Salem Harbor Power Plant. The Salem Harbor Power Plant is included as a major background source even though it is 21.7 km from Mystic and 24.5 km from New Boston. The major background sources meeting the stated size and distance criteria are listed in Table 3-1 and a majority of them are shown in Figure 3-1. Tables of associated stack gas exit parameters and SO_2 emission rates for all major background sources and a discussion of their derivation are contained in Appendix D.

Actual Emissions. Emissions calculated from annual average fuel use and actual hours of operation.

Candidate Edison Units. These are Mystic Units 4, 5 and 6, and New Boston Units 1 and 2. Each of these units is a proposed candidate for coal conversion.

Complying Sulfur Content Coal. The highest percent sulfur content in coal which allows for the maintenance of the SO_2 NAAQS. By agreement with the U.S. EPA and Mass. DEQE the complying sulfur content was based on the primary 24-hour SO_2 standard.

Full Receptor Grid. A grid of 497 receptors which has been approved by the Mass DEQE and EPA Region I.

PSD Source. A major existing, major new permitted source, or a SIP revision which consumes PSD increment. These sources are listed in Appendix D.

Increment Consuming Emission Increases. An increase in SO_2 emissions above a baseline level from a PSD source. For this study

TABLE 3-1

MAJOR BACKGROUND SOURCES OF SO_2 INCLUDED IN THE SEQUENTIAL MODELING

Revere Sugar
Eastman Gelatine*
General Electric (Lynn)
Exxon
Gillette
Cambridge Electric (Kendall Sq)
Cambridge Electric (Blackstone St.)*
Logan International Airport
Natick Paperboard*
Hanscom Field
MATEP
Boston Edison-Kneeland St.
MIT
NEPCO-Salem Harbor
Boston Edison-Mystic 7*
Diamond International*
Proctor & Gamble*

---

*Also consumes PSD increment.

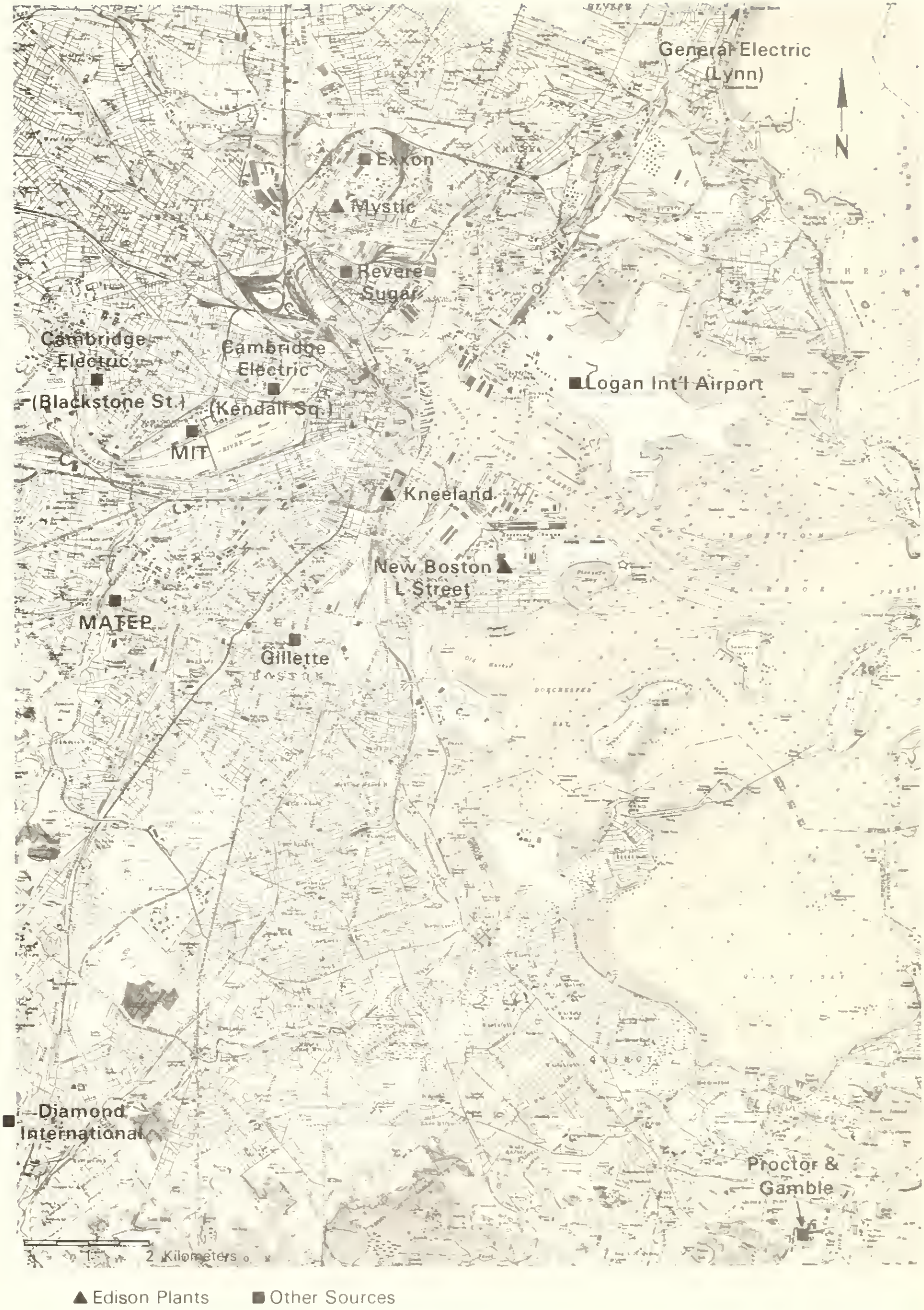


Figure 3-1 Major Sources of Sulfur Dioxide Located within 20 km of the Edison Plants

these include the emission increases for sources listed in Appendix D plus the increases in SO_2 emissions projected for coal-firing at each candidate Edison unit.

PSD Baseline Configuration. The existing configuration of Mystic Units 4, 5, 6, New Boston Units 1 and 2 and L Street at their actual fuel use will consitute PSD baseline conditions. Baseline stack parameters (exit velocity, temperature) for these sources were calculated from fuel use (1% sulfur oil) at the load corresponding to the maximum baseline fuel use defined as maximum daily fuel use over the last 2 years (1980-81) of normal operation. Baseline short term (3- and 24-hour) SO_2 emission rates were based on the maximum daily fuel use over the last two years of normal operation. The baseline annual average SO_2 emission rate was calculated for these sources based on actual conditions, (i.,e. annual fuel use divided by the number of operating hours). Table 3-2 presents SO_2 emission parameters for the baseline sources. As baseline sources they were modeled at a negative emission rate so that the net change in ambient SO_2 concentrations or increment consumption due to the coal conversions could be obtained by adding the baseline concentrations (negative values) to modeled plant concentrations (positive values) assuming coal fired emission rates. Annual average concentrations for the baseline sources were calculated by scaling the hourly concentrations based on maximum fuel use by the ratio of annual average emission rate to the maximum emission rate. The maximum emission rate is the emission rate corresponding to the maximum baseline fuel use.

Signficant Impact Area. The area in which 24-hour average SO_2 impacts from Mystic or New Boston (or both) are at least 5 $\mu g/m^3$.

Primary PSD Baseline Areas. PSD triggered baseline areas within 20 km from both Mystic and New Boston Stations. These include Boston, Milton and Wellesley.

TABLE 3-2

BASELINE EMISSION PARAMETERS FOR BOSTON EDISON STATIONS

Station	Unit	UTM		Existing Stack Height (m)	Base Elevation (m)	Existing Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (ok)	SO2 (g/s)		Worst-Case Building Dimensions Input to ISC		
		East	North						Max	Annual	Height (m)	Length (m)	Width (m)
Mystic (1% S Oil)	4	329.7	4695.1	102.1	3	3.2	22.5	397.0	185.19	159.38	64.6	55.55	55.55
	5	329.7	4695.1	102.1	3	3.2	21.9	396.3	181.11	154.92	64.6	55.55	55.55
	6	329.7	4695.1	102.1	3	3.2	22.4	395.6	185.19	173.99	64.6	55.55	55.55
New Boston (1% S Oil)	1 & 2	332.3	4689.2	76.2	3	3.05	31.4	399.7	934.63	850.05	51.5	68.5	68.5
L Street (1% S Oil)	74, 75, 76	332.3	4689.1	76.2	3	5.49	8.94	423.7	203.52	203.52	51.5	68.5	68.5

Perimeter PSD Baseline Areas. All PSD triggered baseline areas beyond 20 km from both Mystic and New Boston Stations but within the significant impact areas of the Mystic or New Boston Stations. These include Natick, N. Andover, Methuen and Lawrence.

Increment Already Consumed/Perimeter Baseline Area. The level of increment consumed by the permitted PSD source triggering the PSD baseline in a perimeter PSD baseline area. This value was obtained from the DEQE.

Assumptions

I Mystic

- Mystic Units 4, 5 and 6 will be coal fired but will use 2.2% sulfur content fuel oil whenever a coal supply may be unavailable. All emission parameters (SO_2, stack gas exit temperature and exit velocity) used in the sequented modeling will be based on maximum load. The derivation of these parameters is described in Task A. For model input, the SO_2 emission rate for Mystic Units 4, 5 and 6 is based on the 30-day average sulfur content of 1.5%. Table 3-3 presents the emission parameters for Mystic and New Boston under the proposed coal-fired configuration.

- Sulfur dioxide (SO_2) emissions at Mystic are to be vented from two (2) stacks. Oil-fired SO_2 emissions from Unit 7 wil be vented through the existing 500' stack. Coal-fired SO_2 emissions from Units 4, 5, and 6 are to be vented through one common Good Engineering Practice (GEP) stack to be built as part of the coal conversion.

- A previous analysis (ERT document No. P-A376-B, Technical Addendum, October, 1980) performed in support of Boston Edison's request for a SIP revision to burn higher sulfur

TABLE 3-3

BOSTON EDISON SO_2 EMISSION PARAMETERS FOR THE PROPOSED COAL FIRED CONFIGURATION AT NEW BOSTON AND MYSTIC STATIONS

Station	Fuel	Unit	Stack Height (m)	Stack Temperature (°K)	Exit Velocity (m/sec.)	Equivalent Diameter (m)	SO_2 (g/s)	Configuration
Mystic	1.5% S Coal	4, 5, 6	152.4	400.0	35.7	5.54	1421.0	4,5,6,7 at 100% load
Mystic	2.2% S Oil	7	152.4	463.7	27.5 (actual)	5.8	1674.0	
New Boston	1.5% S Coal	1, 2	113.4	400.0	35.4	6.08	2014.0	Units 1, 2, at 100% load

oil at Mystic, indicated that GEP stack height at Mystic varies from 500' to 521'. A 500' GEP height will be assumed for Mystic Units 4, 5, and 6. This document is presented here as Appendix B.

- Although Mystic Unit 7 is included as a major background source, it is being modeled at maximum allowable emissions because it is a SIP revision source.

II New Boston

- New Boston Units 1 and 2 will be coal-fired but will use 2.2% sulfur content fuel oil whenever a coal supply may be unavailable. All emission parameters will be based on maximum load. The derivation of these parameters is described in Task A. For model input the SO_2 emission rate at the New Boston units will be based on the 30-day average sulfur content of 1.5%. Table 3-3 presents the corresponding emission parameters.

- Coal fired emissions from New Boston Units 1 and 2 will be vented through a common 372' stack which is fitted with double flues. The stack, to be built as part of the coal conversion, is less than GEP height (422.5') due to Federal Aviation Administration height restrictions based on proximity to Logan International Airport.

III Major Background Sources

- All major background sources will be modeled at actual SO_2 emissions with stack gas exit parameters calculated from annual fuel usage.

- Salem Harbor coal-fired units 1, 2, and 3 will be modeled as a background source. Emissions from the Salem Harbor coal-fired units were calculated in the following manner. Sulfur emissions were assumed to be at the SIP limit of 1.21 lb sulfur/MMBtu. The firing rate in terms of MMBtu/hour was calculated for each unit by dividing the 1980-81 operating hours into the average Btu/year for each unit. The firing rate was then multiplied by the SIP limit to arrive at an SO_2 emssion rate in pounds per hour.

IV PSD Analysis

- For the PSD baseline configuration (see definition), stack parameters corresponding to maximum baseline fuel use will be the basis for determining increment consumption. For assessing annual average PSD increment consumption from emission increases at the candidate units the modeled hourly concentrations based on maximum baseline fuel use will be scaled to reflect the emission rate at annual average fuel use.

- PSD sources will be modeled at maximum allowable emissions.

- Method of Calculating PSD Increment Consumption. Hourly concentrations representing PSD baseline conditions for Mystic Units 4, 5, 6, New Boston Units 1, 2, and L Street were given a negative value and added to the modeled concentrations for coal firing at the Mystic and New Boston Stations. This in effect gives the net change in ambient SO_2 concentrations due to the coal conversion and is the SO_2 increment consumption due solely to firing coal at each candidate unit. In addition, the SO_2 increment consumption from other valid SO_2 emission increases was added to the coal conversion increment consumption to estimate total SO_2 increment consumption after the conversion. Total SO_2 increment consumption was calculated only in the primary and perimeter baseline areas. All sources in the PSD inventory (Table D-2) consume increment by virtue of a SIP revision (except Natick Paperboard which is a PSD permitted source) which allows each to burn higher sulfur oil. The amount of increment consumed depends on each source's allowed SO_2 emission increase above their baseline emission rate. In determining PSD increment consumption for these SIP revision sources only the increase in SO_2 emissions above baseline were considered. These PSD sources were modeled at stack gas exit velocities, temperatures corresponding to maximum load and SO_2 emission rates corresponding to maximum allowable under the Mass State SIP.

Following is a task by task description of the work scope.

Task A - Determination of Worst-Case SO_2 Load for Each Station

The proposed coal-fired emission configurations at Mystic and New Boston were each modeled separately at several different loads to determine which case produces maximum ground-level impact for each station. EPA's PTPLU, ISC and PTMTP models were used in the analysis. An EPA recommended range of meteorological conditions was input to the model. The worst-case emission configuration identified in this task was used in all subsequent modeling of the proposed emission configurations at Mystic and New Boston.

Appendix C contains modeling procedures and results. These were presented to DEQE and EPA meteorologists at a meeting on June 29, 1982. All parties agreed that the worst-case emission configuration is 100% load at Mystic Units 4, 5, 6 and 7 and 100% load at both New Boston units.

Task B - Selection of Modeling Receptors

Using the results from Task A and other appropriate information, a full grid of 497 receptors was developed for the modeling of the Edison coal conversion candidates and all other major background sources. The DEQE and U.S. EPA have reviewed the grid and have approved it. Appendix E contains the grid coordinates and receptor elevations and Figure 3-2 shows a majority of the receptors in the grid on a map of the Boston area. The corporate boundaries of the primary PSD baseline areas of Boston and Milton are also shown in the Figure.

Receptors were selected based on three criteria: high terrain locations, prevailing downwind directions and proximity to the points of maximum impact from Mystic and New Boston on coal as predicted with the ISC, PTMTP and PTPLU models. The grid was first presented to DEQE/EPA on June 19, 1982. Receptor heights represent the highest terrain feature within that receptor's sphere of influence. The latter varied from a 0.25 to 1.0 km radius depending upon the spacing of nearby receptors. The grid shown in Figure 3-2 incorporates the agencies' request for a dense grid with strategically placed receptors covering major population areas, Mystic-New Boston-Salem harbor (NEPCO) alignment radials, the eleven SO_2 monitor locations and locations of maximum impacts from the previous SIP study for the Mystic Station. The SO_2 monitor locations are also noted in Figure 3-2.

Task C - Sequential (Full Year) Modeling for All Sources

A five-year (1977-1981) sequential modeling study was performed using a modified version of EPA's ISC model. This version of ISC cuts off terrain just below stack top elevation on a stack-by-stack basis, thus allowing sources of varying stack heights to be modeled together. In the unmodified version of ISC, the user would have to truncate terrain at the lowest stack top elevation or make multiple runs. EPA Region I staff made the coding changes and these were

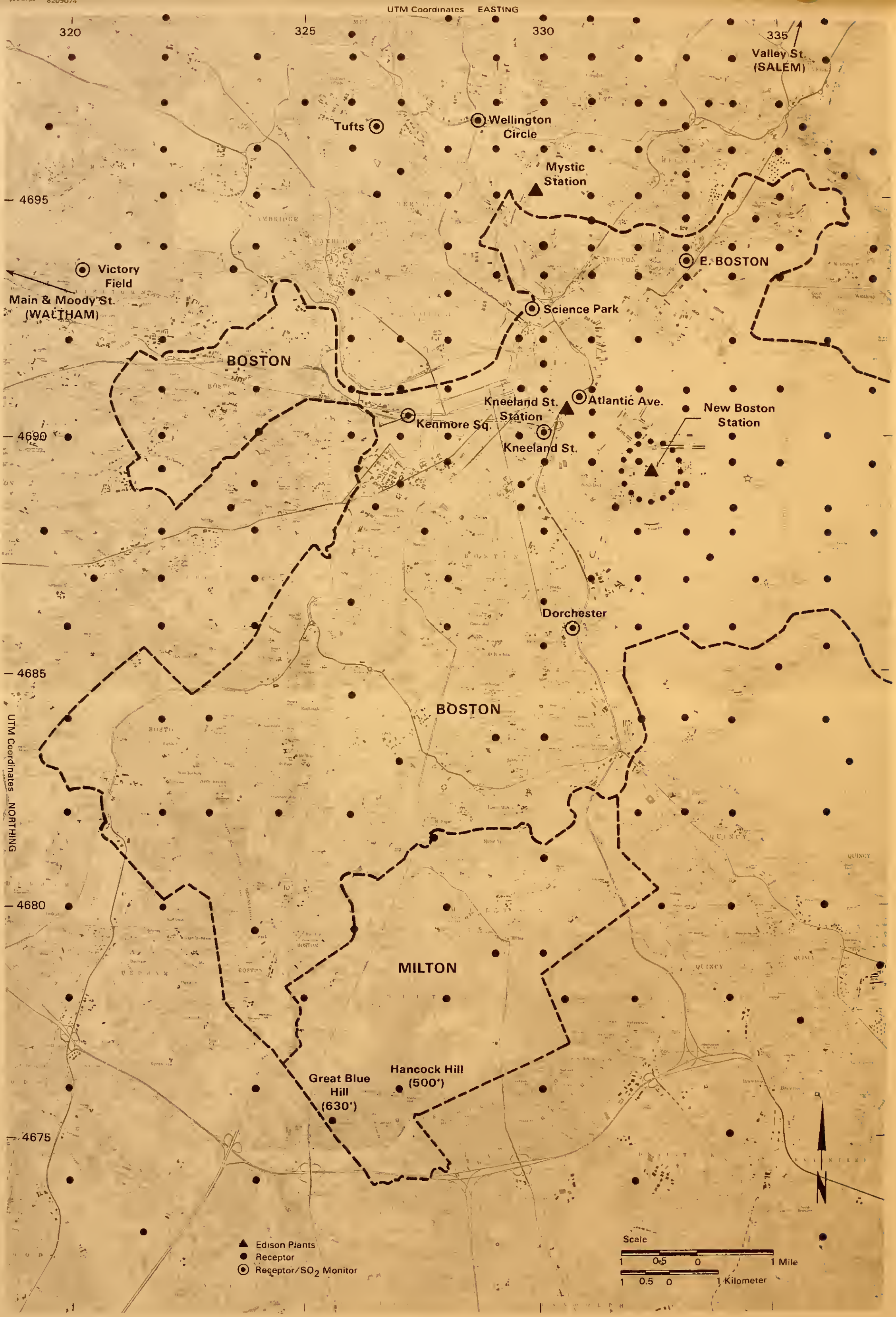


Figure 3-2 Receptor Grid Employed in the ISC Modeling

implemented by ERT on ERT's computer. EPA Region I's test cases were duplicated to ensure that the EPA Region I coding changes were properly made to the ISC model on the ERT computer. Test case results were sent to EPA Region I under separate cover.

Surface meteorological data from Logan Airport and upper air meteorological data from Portland, Maine were processed and used as the bases for model calculations. A total of 497 receptors (from Task B) were input to the model. ISC's urban 1 option, and plume rise options recommended by EPA Region I were used. The EPA Region I guidance was derived from recommendations made by Regional Workshops on Air Quality Modeling: A Summary Report, April 1981. The report listed the plume rise recommendations that were followed. Specifically, the final rise option was used except when the building downwash option was used. In the latter case, transitional plume rise was used. Other options used in the modeling are contained in Table 3-4.

Coal-fired Mystic Units 4, 5 and 6, coal-fired New Boston Units 1 and 2 and all other major SO_2 background sources were modeled sequentially for all five years of meteorology at all 497 receptors. Separate hour-by-hour files were created for:

1. Mystic Units 4, 5 and 6;
2. New Boston Units 1 and 2;
3. Coal-fired Salem Harbor Units;
4. Major existing background sources including Mystic Unit 7 and Salem Harbor oil-fired units;
5. PSD sources.

Background SO_2 concentrations not associated with the major existing background and PSD sources were estimated from ambient SO_2 concentrations measured at representative monitors. Only measurements

TABLE 3-4
ISC MODEL OPTIONS USED IN THE ANALYSIS FOR BOSTON EDISON COAL CONVERSION

Option	Description	
Dispersion Parameters	Urban Mode 1	
Wind Profile Exponent	Stability	Exponent
	A	.15
	B	.15
	C	.20
	D	.25
	E	.30
	F	.30
Vertical Potential Temperature Gradient	Default	
Plume Rise	see note below	
Stack Tip Downwash	Not Used	
Number of Receptors	497	
Entrainment Coefficient for Unstable Atmosphere	Beta 1 = 0.60	
Entrainment Coefficient for Stable Atmosphere	Beta 2 = 0.60	
Anemometer height	10 m	
Decay Coefficient	0.0	
Building Downwash		

Transitional Plume Rise will be used when the building downwash option is used. Otherwise, the final plume rise option will be selected.

which are coincident with the 5-year meteorological data base were used. Thus only ambient SO_2 concentrations measured at representative monitors from 1977 to 1981 were used. ERT met with the U.S. EPA and DEQE and agreed on which ambient SO_2 monitors are representative for background. These monitors and their dates of operation are presented in Table 3-5. Their locations are shown in Figure 3-2. The hour-by-hour SO_2 concentrations were averaged across the network to obtain a network average for that hour. After the averaging was completed for all hours, a sixth hour-by-hour concentration file was created for network averaged 1-hour SO_2 concentrations.

The network averaged hour-by-hour concentrations representing non-modeled background were added to modeled impacts from all sources to determine total 1-hour SO_2 concentrations. The total 1-hour SO_2 concentrations were then appropriately processed to obtain total 24-hour, 3-hour, and annual average ambient SO_2 concentrations at each of the 497 receptors.

Task D Compliance Analysis

D-1. A computer program was written to calculate complying sulfur content fuel for the Mystic and New Boston Stations. The program used the following equation:

$$C_{24\ hrs} = \left[\frac{\text{NAAQS - Background}}{\text{Mystic + New Boston}}\right] * 1.5\%\ \text{sulfur coal} \qquad (3\text{-}1)$$

where

$C_{24\ hrs}$ is the complying sulfur content fuel (%) based on a 24-hour average value.

NAAQS = 365 $\mu g/m^3$ for a 24-hour average.

Background is a file containing 24-hour average monitored concentrations added to modeled impacts from all major background sources at each receptor.

TABLE 3-5

SULFUR DIOXIDE MONITORS USED IN THE BOSTON EDISON COAL CONVERSION STUDY

Station	SAROAD No.	Operating Dates	UTM Easting	UTM Northing	Elevation (ft, msl)
DEQE Sites					
Kenmore Sq. (Boston)	220240002F01	1977-1981	327.100	4690.400	20
Science Pk. (Boston)	220360004F01	1977-1978	329.828	4692.651	25
Wellington Cir. (Medford)	221220003F01	1977-1980	328.600	4696.600	50
Main & Moody Sts. (Waltham)	222340004F01	1977-1978	315.900	4693.500	75
Victory Field (Watertown)	222380005F01	1979-1981	320.310	4693.500	60
Kneeland St. (Boston)	220240015F01	1981	330.000	4690.000	25
Tufts Univ. (Medford)	222100003F01	1980-1981	326.500	4696.550	35
Bremen St. (E. Boston)	220240016F01	1978-1980*	333.000	4693.550	20
Bremen St. (E. Boston)	220240021F01	1980-1981*	333.000	4693.550	20
Private Sites					
Dorchester (Bos. Ed.)	220240020J02	1978-1981	330.548	4685.952	27
E. Boston (Bos. Ed.)	220240016J05	1977-1978*	333.000	4693.550	20
E. Boston (Bos. Ed.)	220240021J02	1978-1981*	333.000	4693.550	20
Atlantic Ave. (Bos. Ed.)	220240018J05	1977-1978	330.762	4690.785	27
Atlantic Ave. (Bos. Ed.)	220240018J02	1978-1981	330.762	4690.785	27
Valley St. (Salem, NEPCO)	221980002J05	1978-1981	342.900	4708.200	75

---

*During periods when both a Boston Edison and a DEQE monitoring are operating, data from the DEQE site was used in developing an SO_2 background concentration.

Mystic	is a computer file of 24-hour average impacts from Mystic at all 497 receptors.
New Boston	is a computer file of 24-hour average impacts from New Boston at all 497 receptors.
1.5% sulfur	is the maximum expected 30 day average sulfur content in the coal.

The computer program was run for each year of the 5-year modeling period. Complying coal sulfur contents were calculated at all receptors having any impact from Mystic or New Boston. Since Mystic and New Boston files are treated separately in the equation, it is theoretically possible for New Boston's complying coal sulfur content to be calculated at a receptor and during a meteorological period having no contribution from the Mystic Station. The same is true for Mystic's limiting complying sulfur coal, i.e., it could occur during a meteorological day and at a receptor having no impact from the New Boston Station. It is also possible for the complying sulfur content coal for both stations to be calculated during meteorological day when the two stations interact at a common downwind receptor. Under this circumstance the complying sulfur content will be the same for both stations.

D-2. At each receptor for each day of the five year period, the hourly concentrations from Mystic and New Boston coal-fired emissions were scaled to reflect the complying sulfur content coal calculated above. The scaled concentrations were added to hourly monitored and modeled background concentrations contributed by major sources and 3-hour block averages were calculated at each receptor for each day of the 5-year period. The highest and second-highest 3-hour total ambient SO_2 concentrations at each receptor were then compared to the NAAQS of 1,300 $\mu g/m^3$.

Task E - PSD Increment Consumption Analysis

E-1. The PSD baseline conditions were modeled for the Mystic, New Boston and L Street Stations. These sources were modeled at a negative emission rate to simulate their replacement with coal fired units (Mystic Units 4, 5, 6, New Boston Units 1, 2) and to simulate retirement (L-Street). Boston Edison takes an emission credit for retiring L Street since its retirement is contemporaneous (within 5 years) with the coal conversions. The hour-by-hour concentrations were stored in a separate computer file.

E-2. For primary PSD baseline areas (see Figure 3-2), the PSD concentration files created in Tasks C and E-1 were appropriately summed to net out the level and pattern of increment consumption at the receptors in each primary baseline area.

E-3. In the perimeter PSD baseline areas, the ISC model was used to calculate PSD increment consumption from Mystic, New Boston and all other PSD increment consuming sources at the receptor of maximum predicted increment consumption for the permitted PSD source which triggered the PSD baseline in that area.

E-4. If the sum in E-3 was less than the allowable increment, no further modeling was performed. If the sum was above the allowable increment, additional 5-year modeling for other receptors in the baseline area were modeled to more accurately assess the actual level of increment consumption within the baseline area. Such additional modeling was required for Natick only and was performed for receptors downwind of Natick Paperboard along radials that align this source with Mystic and New Boston Stations. This modeling was required because Natick Paperboard consumes 79 $\mu g/m^3$ of the 91 $\mu g/m^3$ 24-hour PSD increment at its receptor of maximum impact and a projected level of greater than $91/ug/m^3$ was estimated using the procedure outlined in E-3. It was therefore necessary to perform additional modeling at these lineup receptors to demonstrate that Natick Paperboard's interaction with Boston Edison Stations will not consume more than the allowable PSD increment for the 24-hour averaging period. Natick Paperboard is the permitted PSD source triggering the PSD baseline in Natick.

4. COMPLIANCE ASSESSMENT

The ambient SO_2 and coal sulfur content compliance assessments are presented in this section. The results are presented in four subsections.

- In subsection 4.1 we present the highest projected total 24-hour SO_2 concentrations under the assumption that each candidate unit would be fired on a coal with a constant and average sulfur content of 1.5 %.
- In subsection 4.2 we present the complying sulfur content assessment. That is, we present the highest 24-hour average sulfur content for each candidate station which allows for the maintenance of the primary 24-hour standard.
- In subsection 4.3 we present the highest projected total 3-hour SO_2 concentrations under the assumption that each candidate unit is firing coal with a constant sulfur content which set equal to the complying sulfur content presented in 4.2.
- In subsection 4.4 we present the expected annual average concentrations assuming that each candidate unit is fired on a coal with a constant and average sulfur content of 1.5%.

Please note that we are using the highest-second-highest simulated concentration as the basis for compliance. The highest-second-highest concentration is determined by discarding the highest concentration at each receptor and then selecting the highest of the remaining concentrations. Since the highest of the remaining concentrations is obviously a second highest concentration at a particular receptor, it is the highest of all the second highests and is referred to as the highest-second-highest. The use of the highest-second-highest is based on U.S. EPA policy. Agency policy allows the use of the highest-second-highest when multiple years, preferably five, of meteorological data are used as the basis for model simulations. This policy is an extension of the agency's guidance on the use of measured ambient concentrations. Since the regulations allow the short-term ambient standards to be exceeded once per year at each monitor, the highest-second-highest measured concentration is used by state air pollution agencies and the U.S. EPA as the basis for assessing regional compliance with NAAQS.

4.1 24-Hour Average SO_2 Concentrations (Candidate Units At A Constant Sulfur Content of 1.5%)

Tables 4-1 and 4-2 present the highest 24-hour average SO_2 concentrations predicted within the primary PSD baseline area and outside of the primary PSD baseline region, respectively. The candidate units at Mystic and New Boston are assumed to be burning a constant 1.5% sulfur content coal. Following is a discussion of the results.

The highest 24-hour average for the 5-year modeling period within the primary PSD baseline region is 198.7 $\mu g/m^3$. This concentration was predicted to occur on day 015 during meteorological year 1981 at receptor #008 (refer to Appendix E for receptor locations). Receptor #008 is located on a 180' hilltop in east Milton and is approximately 10.5 km SSW of the New Boston Station and 16 km south of Mystic. Persistent north winds which ranged from 3-6 m/sec would advect the SO_2 emissions from upwind sources (Mystic, New Boston and other major sources) toward the hill under neutral atmospheric conditions. The 198.7 $\mu g/m^3$ value represents 54% of the 365 $\mu g/m^3$ NAAQS.

The highest of all second highest predicted concentrations within the primary baseline zone for the 5-year period is 183.1 $\mu g/m^3$. This concentration was predicted to occur on day 016 in meteorological year 1980 at receptor #002. Receptor #002 is located on top of Hancock Hill in the Blue Hill Range (Milton) at an elevation of 500'. Moderate to strong (6-9 m/sec) north to NNE winds would advect SO_2 emissions from Mystic, New Boston and other upwind sources toward Hancock Hill during neutral atmospheric conditions. The concentration of 183.1 $\mu g/m^3$ predicted at this receptor on this day has added significance because it also is the simulated concentration from which the complying sulfur content coal was calculated for both candidate stations. Further discussion of individual source contributions to the 183.1 $\mu g/m^3$ concentration and the complying fuel calculation is presented in the next section.

TABLE 4-1

HIGHEST 24-HOUR AVERAGE SO_2 CONCENTRATIONS PREDICTED IN THE PRIMARY PSD BASELINE AREA

(CANDIDATE UNITS AT 1.5% SULFUR CONTENT COAL)

Year	Day	Receptor Location	Concentration ($\mu g/m^3$)	Category
1977	054	Boston/Brookline Bndry (Rec #082)	163.3	Highest
	287	Boston/Brookline Bndry (Rec #082)	159.3	Highest-Second Highest
1978	048	Boston Harbor (Rec. #057)	169.6	Highest
	048	Boston Harbor (Rec. #037)	164.2	Highest-Second Highest
1979	050	Milton, Great Blue Hill (Rec #001)	194.3	Highest
	057	Boston, Hyde Park (Rec #005)	154.2	Highest-Second Highest
1980	015	Milton, Hancock Hill (Rec #002)	193.0	Highest
	016	Milton, Hancock Hill (Rec #002)	183.1*	Highest-Second Highest*
1981	015	Milton (Rec #008)	198.7	Highest
	015	Boston Harbor (Rec #076)	165.1	Highest-Second Highest

---

*Highest-second-highest concentration for the 5-year meteorological period for receptors within the primary PSD baseline area. This day, receptor and concentration is also the limiting case for the complying fuel calculation for both Mystic and New Boston.

NOTE: 24-Hour NAAQS = 365 $\mu g/m^3$.

TABLE 4-2

HIGHEST 24-HOUR AVERAGE SO_2 CONCENTRATIONS PREDICTED OUTSIDE THE PRIMARY PSD BASELINE AREA (CANDIDATE UNITS AT 1.5% SULFUR CONTENT COAL)

Year	Day	Receptor Location	Concentration ($\mu g/m^3$)	Category
1977	034	Beverly (Rec #275)	238.7	Highest
	069	Manchester (Rec #276)	231.2*	Highest-Second Highest
1978	195	Beverly (Rec #275)	236.4	Highest
	024	Beverly (Rec #275)	203.9	Highest-Second-Highest
1979	060	Salem/Peabody Bndry (Rec #225)	263.2	Highest
	346	Beverly (Rec #275)	202.6	Highest-Second Highest
1980	353	Manchester (Rec #276)	276.1	Highest
	050	Beverly (Rec #275)	185.7	Highest-Second Highest
1981	015	Salem/Peabody Bndry (Rec #225)	247.5	Highest
	054	Salem/Peabody Bndry (Rec #225)	229.4	Highest-Second Highest

---

*Highest-second-highest concentration for the 5-year meteorological period for receptors outside of the primary PSD baseline area.

NOTE: 24-Hour NAAQS = 365 $\mu g/m^3$.

Highest predicted 24-hour average SO_2 concentrations outside of the primary PSD baseline area are presented in Table 4-2. All of the highest and highest-second-highest concentrations are simulated to occur to the northeast of both candidate stations (north shore). For the 5-year period the highest predicted concentration is 276.1 $\mu g/m^3$. This value, predicted to occur on day 353 during meteorological year 1980, is 88.9 $\mu g/m^3$ below the 24-hour NAAQS of 365 $\mu g/m^3$. The 276.1 $\mu g/m^3$ was predicted to occur on a hilltop (elev. 218' MSL) in Manchester, MA. at receptor #276 Moderate (5-6 m/sec) SW winds accompanied by a neutral atmosphere would advect the SO_2 emissions of upwind sources (Salem Harbor, Mystic, and other major sources) toward the hill. The highest of all second highest concentrations predicted over all receptors outside of the primary PSD baseline area also occurs at receptor #276. This concentration, 231.2 $\mu g/m^3$, was predicted to occur on day 069 during meteorological year 1977. Meteorological conditions on this day were similar to day 353 in 1980 which produced the highest concentration for the 5-year period.

Table 4-3 presents a ranking of the twenty-five highest 24-hour meteorological days based on predictions of 24-hour average SO_2 concentrations over all 497 receptors for the 5-year modeling period. The candidate coal conversion stations are assumed at 1.5% sulfur content coal. Values presented in the Table represent the highest concentration predicted during a particular meteorological day. For example, on day 353 in 1980 a concentration of 244.4 $\mu g/m^3$ was predicted to occur at receptor #275 but it is not reprinted in the top twenty five because the 276.1 $\mu g/m^3$ concentration predicted at receptor #276 is the highest or ranking predicted concentration for this meteorological day. The 244.4 $\mu g/m^3$ is the highest value calculated at a receptor on that day but is not the highest over all receptors for that day. The twenty-five highest ranking values range from 187.8 $\mu g/m^3$ to 276.1 $\mu g/m^3$ or from 177.2 $\mu g/m^3$ to 88.9 $\mu g/m^3$ below the 24-hour NAAQS of 365 $\mu g/m^3$. Most of these concentrations occur to the north of Boston and are outside of the primary PSD baseline areas. Those of the top 25 that occur within the primary PSD baseline area are identified in the table.

TABLE 4-3

TWENTY-FIVE HIGHEST 24-HOUR AVERAGE CONCENTRATION DAYS PREDICTED BY THE ISC MODEL

(CANDIDATE UNITS AT 1.5% SULFUR CONTENT COAL)

Year	Day	Receptor Location	Concentration (μg/m^3)
1980	353	Manchester (Rec #276)	276.1
1979	060	Salem/Peabody Bndry (Rec #225)	263.2
1981	015	Salem/Peabody Bndry (Rec #225)	247.5
1977	034	Beverly (Rec #275)	238.7
1978	195	Beverly (Rec #275)	236.4
1979	052	Beverly (Rec #275)	236.3
1977	069	Manchester (Rec #276)	231.2
1981	054	Salem/Peabody Bndry (Rec #225)	229.4
1977	024	Manchester (Rec #276)	218.8
1979	050	Quincy (Rec #103)	212.6
1978	135	Salem (Rec #240)	204.5
1978	024	Beverly (Rec #275)	203.9
1979	346	Beverly (Rec #275)	202.6
1981	319	Brookline (Rec #295)	201.1
1978	013	Quincy (Rec #103)	198.5
1978	236	Salem/Peabody Bndry (Rec #225)	193.9
1978	349	Beverly (Rec #275)	193.2
1980	015	Milton (Rec #002 - Primary PSD Area)	193.0
1980	364	Mass. Bay (Rec #258)	191.8
1978	346	Manchester (Rec #276)	190.9
1977	055	Peabody (Rec #209)	189.5
1981	016	Weymouth (Rec #192)	188.3
1977	040	Manchester (Rec #276)	188.2
1978	048	Peabody (Rec #165)	187.8
1977	241	Manchester (Rec #276)	187.8

NOTE: 24-Hour NAAQS = 365 μg/m^3.

4.2 Complying Sulfur Content Assessment

In subsection 4.1 the results reflect the use of a coal with a constant (average) 1.5% sulfur content in each candidate unit. However, since the coal sulfur content is variable, the actual average coal sulfur content over a short period, say 24-hours, could significantly differ from the average over a longer period, say 30 days. The purpose of the complying sulfur content assessment is to determine how much sulfur variability is acceptable. This is done by applying Equation 3-1 to every simulated 24-hour concentration to calculate the highest acceptable 24-hour average sulfur content. By acceptable we mean the highest average 24-hour sulfur content which ensures compliance with the primary standard. Since the results in subsection 4.1 indicate that the primary 24-hour SO_2 standard will be maintained by a wide margin at a constant 1.5% sulfur content coal, we should expect the complying sulfur content to be significantly greater than 1.5%. Since the standard allows 1 exceedence per year at each receptor, the complying sulfur content or highest acceptable 24-hour average sulfur content is the lowest of the lowest-second lowest limiting sulfur content calculated by Equation 3-1. The lowest limiting sulfur content calculated by Equation 3-1 would ensure that the standard is never exceeded at any receptor. The second lowest limiting sulfur content at a receptor allows the standard to be exceeded only once at that receptor. The lowest of the second lowest will allow the standard to be exceeded only once at any of the receptors but ensures that it could never happen twice. Thus the calculated lowest-second-lowest for each meteorological year would prevent a violation of the standard over all receptors. Since a lowest-second-lowest is calculated for each meteorological year, the complying sulfur content is the lowest of all the lowest-second-lowests over the 5-year meteorological record.

The most limiting 24-hour sulfur contents for the candidate Mystic and New Boston units are shown in Tables 4-4 and 4-5. The lowest limiting sulfur content for each candidate station is 4.16% and is derived from a simulated 24-hour concentration for a meteorological

TABLE 4-4

COMPLYING SULFUR CONTENT LIMITATIONS FOR THE MYSTIC STATION

			24-Hour Average Source Contributions ($\mu g/m^3$)					
Year	Day	Receptor Location	Mystic	New Boston	Background	Total ($\mu g/m^3$)	Limiting Sulfur Content (%)	Category*
1977	287	Boston (Rec #015 Primary PSD Area)	4.8	92.1	43.1	140.0	4.98	Lowest
	055	Waltham (Rec #008)	40.8	10.7	92.8	144.3	>5.0	Lowest-Second Lowest
1978	013	Quincy (Rec #103)	34.6	32.5	131.4	198.5	>5.0	Lowest
	326	Quincy (Rec #103)	43.2	24.0	107.3	174.5	>5.0	Lowest-Second Lowest
1979	117	Stoneham (Rec #082)	36.8	49.2	61.8	147.8	>5.0	Lowest
	050	Quincy (Rec #103)	17.7	20.0	174.9	212.6	>5.0	Lowest-Second Lowest
1980	015	Milton (Rec #002 Primary PSD Area)	26.7	70.2	96.1	193.0	4.16	Lowest
	016	Milton (Rec #002 Primary PSD Area)	19.6	68.3	95.2	183.1	4.60**	Lowest-Second Lowest
1981	319	Brookline (Rec #042 Primary PSD Area)	63.3	0.0	134.5	197.8	>5.0	Lowest
	057	Quincy (Rec #103)	26.9	40.7	67.0	134.6	>5.0	Lowest-Second Lowest

---

*Lowest is the lowest limiting sulfur content over all 497 receptors.
Lowest-second lowest is the lowest of all second lowest limiting sulfur contents calculated over all 497 receptors.
**Complying coal sulfur content for both Mystic and New Boston.

NOTE: 24-Hour NAAQS = 365 $\mu g/m^3$.

TABLE 4-5

COMPLYING SULFUR CONTENT LIMITATIONS FOR THE NEW BOSTON STATION

			24-Hour Average Source Contributions ($\mu g/m^3$)			Total	Limiting	
Year	Day	Receptor Location	Mystic	New Boston	Background	($\mu g/m^3$)	Sulfur Content (%)	Category*
1977	287	Boston (Rec #015)	4.8	92.1	43.1	140.0	4.98	Lowest
	263	Boston (Rec #015)	0.3	69.7	37.9	107.9	>5.0	Lowest-Second-Lowest
1978	013	Quincy (Rec #103)	34.6	32.5	131.5	198.6	>5.0	Lowest
	326	Quincy (Rec #103)	43.2	24.0	107.3	174.5	>5.0	Lowest-Second Lowest
1979	117	Stoneham (Rec #082)	36.8	49.2	61.8	147.8	>5.0	Lowest
	050	Quincy (Rec #103)	17.7	20.0	174.9	212.6	>5.0	Lowest-Second-Lowest
1980	015	Milton (Rec #002 Primary PSD Area)	26.7	70.2	96.1	193.0	4.16	Lowest
	016	Milton (Rec #002 Primary PSD Area)	19.6	68.3	95.2	183.1	4.60**	Lowest-Second-Lowest
1981	339	Quincy (Rec #103)	32.1	38.5	98.7	169.3	>5.0	Lowest
	057	Quincy (Rec #103)	26.9	40.7	67.0	134.6	>5.0	Lowest-Second-Lowest

---

*Lowest is the lowest limiting sulfur content over all 497 receptors.
Lowest-second lowest is the lowest of all second lowest limiting sulfur contents calculated over all 497 receptors.
**Complying coal sulfur content for both Mystic and New Boston.

NOTE: 24-Hour NAAQS = 365 $\mu g/m^3$.

event (day 015) in meteorological year 1980 at a receptor atop Hancock Hill in Milton. The lowest of the lowest-second-lowest or the complying fuel for each candidate station is 4.6% and this value was derived from a simulated 24-hour concentration for a meteorological event (day 016) in meteorological year 1980 at the same receptor. Meteorological conditions on both days were similar and consisted of moderate to strong (7-10 m/sec) north to NNE winds accompanied by a neutral atmosphere. As shown in Table 4-4 and 4-5 the Mystic and New Boston Units interact on meteorological days 015 and 016 during meteorological year 1980 which is why the most limiting sulfur content and the complying sulfur content are the same for each candidate unit.

Table 4-6 presents the highest 24-hour average SO_2 concentrations assuming Mystic and New Boston were firing the 4.6% complying sulfur content coal for every hour of the 5-year modeling period. Note that receptor locations and meteorological days of maximum total concentrations in Table 4-6 are a subset of those days contained in Tables 4-4 and 4-5. Simulated Mystic and New Boston SO_2 contributions were scaled up by the ratio of 4.6% to 1.5% because the original modeling was based on 1.5%

The highest predicted total ambient SO_2 concentration with each candidate at 4.6% sulfur content coal for the 5-year period is 393.3 $\mu g/m^3$. This exceeds the 24-hour NAAQS by 28.7 $\mu g/m^3$. This value is predicted to occur during meteorological year 1980 on day 015, the day associated with the most limiting coal sulfur content (4.16%) in Tables 4-4 and 4-5. Since complying sulfur coal is 4.6% and is based on an allowed exceedance of the 24-hour NAAQS, the 393.3 $\mu g/m^3$ represents that exceedance. There were no other predicted exceedances of the 24-hour NAAQS at any other receptor for any of the 5-years modeled. The highest-second-highest predicted total of 364.7 $\mu g/m^3$ is associated with the meteorological day and receptor at which the complying sulfur content coal of 4.6% was calculated.

TABLE 4-6

HIGHEST 24-HOUR AVERAGE SO_2 CONCENTRATIONS WITH MYSTIC AND NEW BOSTON AT COMPLYING SULFUR CONTENT COAL (4.6%)

Year	Day	Receptor Location	Source Contributions ($\mu g/m^3$) Mystic	New Boston	Background	Total ($\mu g/m^3$)	Category*
1977	287	Boston (Rec #015 Primary PSD Area)	14.7	282.4	43.1	340.2	Highest
	263	Boston (Rec #015 Primary PSD Area)	0.9	213.7	37.9	252.5	Highest-Second-Highest
1978	013	Quincy (Rec #103)	106.1	99.7	131.5	337.3	Highest
	326	Quincy (Rec #103)	132.5	73.6	107.3	313.4	Highest-Second-Highest
1979	117	Stoneham (Rec #082)	112.9	150.9	61.8	325.6	Highest
	050	Quincy (Rec #103)	52.3	61.3	174.9	288.5	Highest-Second-Highest
1980	015	Milton (Rec #002 Primary PSD Area)	81.9	215.3	96.1	393.3**	Highest
	016	Milton (Rec #002 Primary PSD Area)	60.1	209.4	95.2	364.7	Highest-Second-Highest
1981	339	Quincy (Rec #103)	98.4	118.1	98.7	315.2	Highest
	057	Quincy (Rec #103)	82.5	124.8	67.0	274.3	Highest-Second-Highest

---

*Highest is the highest predicted concentration over all 497 receptors.
Highest-second highest is the highest of all second highest concentrations calculated over all 497 receptors.

**One exceedance of the 24-hour NAAQS of 365 $\mu g/m^3$ is allowed at each receptor each year.

Note: 24-Hour NAAQS = 365 $\mu g/m^3$.

It should be understood that the concentrations presented in Table 4-6 represent the joint probability that the candidate units will fire coal with a 4.6% average sulfur content during a period of limiting meteorology. Although a rigorous statistical assessment is not presented as part of this study, it should be obvious that the probability of such a joint event occurring is extremely low. Since the average sulfur content of all 24-hour average sulfur contents is assumed to be 1.5%, there will be a far greater opportunity for the actual 24-hour sulfur content to be less than 4.6% during a period of limiting meteorology. In fact, if we assume that 1.5% sulfur content is the arithmetic mean within a geometric distribution of 24-hour sulfur contents, which is one reasonable assumption, we should expect the 24-hour sulfur content to be 1.5% or less 70% of the time. This means when critical meteorological events occur we should expect to see ambient SO_2 concentrations which reflect 1.5% sulfur content or less at least 70% of the time. Thus the combination of limiting meteorology and a 4.6% 24-hour sulfur content would be an extremely rare and absolute worst case event which certainly would not occur every year. Another factor lowering the probability of such an event is the assumption that each candidate unit will fire 4.6% sulfur content coal during the same critical period of meteorology. Again, it should be clear, even without supporting information on the distribution of 24-hour sulfur contents, that the probability of such joint occurrences are miniscule.

We expect if rigorous analyses were performed that the calculated probability for seeing the concentrations presented in Table 4-6 would be very close to 0. Therefore, we caution the reader to understand that the concentrations presented in Table 4-6 represent rare and absolute worst-case events and that it is much more probable that the maximum total 24-hour SO_2 concentrations will be much lower. The 24-hour SO_2 concentrations presented in Table 4-1 and 4-2 are more typical of what should be expected as maximum concentrations.

4.3 3-Hour Average SO_2 Concentrations (Candidate Units at Complying Sulfur Content Coal - 4.6%)

The hourly concentration file for each candidate unit was scaled to reflect the constant use of a coal with 4.6% sulfur content. Results are presented in Table 4-7. The highest total of 1864.4 $\mu g/m^3$ was predicted to occur on day 038 during meteorological year 1978 during a period of strong (18.5 m/sec) winds from the northeast. The strong persistent wind would cause SO_2 emissions from New Boston Station to rapidly disperse to ground level causing relatively high near-field impacts. The highest-second-highest 3-hour average of 1253.6 $\mu g/m^3$ for the 5-year period was predicted to occur at the same receptor (#157) for the previous 3-hour period. Again, strong NE winds (16-22.5 m/sec) would cause near-field impacts from the New Boston Station. Although the 1864.4 $\mu g/m^3$ highest 3-hour total exceeds the corresponding NAAQS of 1300 $\mu g/m^3$, the second-highest concentration of 1253.6 $\mu g/m^3$ does not exceed the NAAQS. A violation of the NAAQS has, therefore, not been predicted since one exceedance is allowed each year at each receptor. As indicated in Table 4-7, no other exceedances of the 1300 $\mu g/m^3$ NAAQS were predicted over all 497 receptors for the 5-year period.

Apart from 1978, highest 3-hour average concentrations were predicted to occur during midday and most were caused by light to moderate winds (4-6 m/sec) and slightly to moderately unstable atmospheric conditions which served to rapidly diffuse the SO_2 emissions from the candidate units. All of the highest and highest-second-highest concentrations listed in Table 4-7 have, as a majority contributor, either Mystic or New Boston Station since all of these highest impacts occur within 5-10 km of both stations and one of the stations was directly upwind of the particular receptor for most, if not all, of the 3-hour period.

Again, the reader is cautioned to understand that the results presented in Table 4-7 represent the joint probability of a 3-hour average sulfur content of 4.6% and limiting meteorology. Based on

TABLE 4-7

HIGHEST 3-HOUR AVERAGE SO_2 CONCENTRATIONS WITH MYSTIC AND NEW BOSTON AT COMPLYING SULFUR CONTENT COAL (4.6%)

Year	Day	3-Hours Ending	Receptor Location	Concentration ($\mu g/m^3$)	Category*
1977	140	1200	Medford (Rec #088)	1118.4	Highest
	135	1500	Cambridge (Rec #083)	757.0	Highest-Second-Highest
1978	038	0300	Boston (Rec #157 Primary PSD Area)	1864.4**	Highest
	037	2400	Boston (Rec #157 Primary PSD Area))	1253.6	Highest-Second-Highest
1979	193	1500	Boston (Rec #047 Primary PSD Area)	1135.6	Highest
	171	1200	Boston (Rec #047 Primary PSD Area)	964.8	Highest-Second-Highest
1980	145	1200	Brookline (Rec #058)	1069.8	Highest
	185	1200	Brookline (Rec #058)	889.9	Highest-Second-Highest
1981	033	1500	Boston (Rec #147 Primary PSD Area)	978.2	Highest
	041	1200	Medford (Rec #076)	809.4	Highest-Second-Highest

---

*Highest is the highest predicted concentration over all 497 receptors. Highest-second-highest is the highest of all second highest concentrations calculated over all 497 receptors.

**One exceedance of the 3-hour NAAQS of 1300$\mu g/m^3$ is allowed at each receptor each year.

rationale presented at the end of subsection 4.2, it should be obvious that the joint probability of such a rare and worst-case event is extremely low or miniscule. We would expect that for any given year the total 3-hour SO_2 concentrations would be much lower than presented in Table 4-7.

4.4 Annual Average SO_2 Concentrations (Candidate Units at 30-Day Average Coal Sulfur Content - 1.5%)

Highest annual average SO_2 concentrations for each modeled year are presented in Tables 4-8 and 4-9 for the primary PSD baseline area and outside of the primary PSD baseline area,respectively. In calculating the annual averages modeled concentrations for each hour at each receptor were added to the monitored network average background for that hour. The network average background is thus a constant value for each hour regardless of receptor location whereas modeled concentrations vary from receptor to receptor. An annual average value was then calculated at each receptor for each year.

The highest annual average concentration in the primary PSD baseline area was predicted to occur for meteorological year 1977 at receptor #135 in northern portions of Boston on the Mystic River. The total of 52.9 $\mu g/m^3$ represents 66% of the 80 $\mu g/m^3$ annual average NAAQS. Of the total, 38.0 $\mu g/m^3$ was contributed by the monitored background and 14.9 $\mu g/m^3$ was added from modeled sources. From 1977 to 1981 a general lowering in the highest annual average concentration can be seen in Table 4-8. This is due to a lowering of annual average monitored background values from a high of 38-40 $\mu g/m^3$ in 1977-1978 to 33.9 $\mu g/m^3$ in 1981. Although statistical tests have not been performed on these data, it appears from Table 4-8 that there has been a general improvement in SO_2 air quality since 1977-1978.

Table 4-9 presents the highest annual average SO_2 concentrations predicted outside of the primary PSD baseline areas. The highest annual average concentration of 61.7 $\mu g/m^3$ was predicted for meteorological year 1977. This value, which is

TABLE 4-8

HIGHEST ANNUAL AVERAGE SO_2 CONCENTRATIONS PREDICTED IN THE PRIMARY PSD BASELINE AREA

		Source Contributions ($\mu g/m^3$)		
Year	Receptor Location	Modeled Sources	Monitored Background*	Total ($\mu g/m^3$)
1977	Boston (Rec #135)	14.9	38.0	52.9
1978	Boston (Rec #132)	11.8	40.0	51.8
1979	Boston (Rec #135)	13.0	35.9	48.9
1980	Boston Harbor (Rec #038)	13.9	35.2	49.1
1981	Boston Harbor (Rec #057)	14.2	33.9	48.1

---

*Represents a regional annual average background concentration as it is the average of all hourly monitored values for that particular year.

Note: Annual average NAAQS for SO_2 = 80 $\mu g/m^3$.

TABLE 4-9

HIGHEST ANNUAL AVERAGE SO_2 CONCENTRATIONS PREDICTED OUTSIDE THE PRIMARY PSD BASELINE AREA

		Source Contributions ($\mu g/m^3$)		
Year	Receptor Location	Modeled Sources	Monitored Background*	Total ($\mu g/m^3$)
1977	Peabody (Rec #241)	23.7	38.0	61.7
1978	Marblehead (Rec #261)	21.5	40.0	61.5
1979	Marblehead (Rec #261)	21.5	35.9	57.4
1980	Marblehead (Rec #261)	23.5	35.2	58.7
1981	Marblehead (Rec #261)	20.8	33.9	54.7

---

*Represents a regional annual average background concentration as it is the average of all hourly monitored values for that particular year.

Note: Annual average NAAQS for SO_2 = $80 \mu g/m^3$.

18.3 μg/m^3 below the annual average NAAQS, was predicted to occur in eastern portions of Peabody at receptor #241. The highest annual average concentrations predicted for the remaining modeled years all occur in Marblehead at receptor #261. Contributions from modeled sources for the 5-year period ranged from 20.8 μg/m^3 to 23.7 μg/m^3 while the monitored background contributed 33.9 μg/m^3 to 40.0 μg/m^3.

In summary, the annual average NAAQS will be maintained by a wide margin if the coal fired at Mystic units 4, 5 and 6 and New Boston units 1 and 2 maintains a 30-day average sulfur content of 1.5%.

5. PSD SO_2 INCREMENT ASSESSMENT

Predicted levels of SO_2 increment consumption are presented in this section for all triggered PSD baseline areas. As discussed in Section 3 we have separated the triggered PSD baseline areas into primary and perimeter baseline areas. A primary baseline area is a triggered or significantly affected Section 107 area within 20 km of either the Mystic or New Boston Station. Primary areas include Milton, Boston, and Wellesley. A perimeter baseline area is a triggered or significantly affected Section 107 area beyond 20 km of both the Mystic and New Boston Stations. Perimeter areas include Natick, North Andover, Methuen, and Lawrence.

Different procedures were used to predict increment consumption in each category of area. In a primary baseline area SO_2 increment consumption was predicted at densely placed receptors within each area. All documented increment consuming emission increases within 20 km of either candidate station were modeled and are the basis for the increment consumption predictions at each receptor. Documented increment consuming emission increases within 20 km of either station include those listed in Appendix D and the increases in SO_2 emissions projected for coal firing at each candidate unit.

In a perimeter area the increment consumption due to all documented increment consuming increases within 20 km of either candidate station was predicted for 5 years of meteorology at one receptor within each perimeter area. In N. Andover, Methuen and Lawrence the receptor chosen for modeing was the closest receptor to Mystic and New Boston. In Natick the chosen receptor was the point of maximum impact from Natick Paperboard (Walnut Hill). The highest predicted level of increment consumption predicted at each of these receptors was then added to the highest predicted level of increment consumption for the PSD source triggering the baseline in that area. This procedure is conservative because two maximum predicted (modeled) concentrations which are not coincident in meterology or time are being added as a first-cut (worst-case) estimate of increment consumption. If this conservative procedure demonstrated maintenance of all applicable increments, no further analysis was performed. If maintenance with an increment in a perimeter area was not demonstrated by this procedure, further modeling for that baseline area was conducted. That is, 5 years of additional hour-by-hour modeling for all documented increment consuming emission increases and the PSD source triggering the baseline in that area was performed at receptor locations within the perimeter baseline area such that the interaction among the candidate Edison units and the triggering PSD source was more accurately simulated in time or coincident meteorology. The only perimeter baseline area requiring such further detailed assessment was Natick and this was only needed for the 24-hour averaging period.

In Sections 5.1 and 5.2, we present the highest modeled 3-hour and 24-hour SO_2 concentrations to demonstrate compliance with the increments. However, since a 5-year meteorological data base was used as a basis for the modeling assessment, regulatory policy allows for compliance with increments to be based on a highest-second-highest modeled concentration. This policy is derived from the fact that increment compliance allows one exceedence of the increment threshold at each receptor or monitor location for each year modeled. Therefore we have also presented the highest-second-highest modeled 3-hour and 24-hour concentrations as a more technically accurate assessment of the actual level of increment consumption for the primary baseline areas. However, the issue of compliance is clearly demonstrated by the highest modeled 3-hour and 24-hour SO_2 concentration. In the perimeter PSD baseline areas only the highest predicted 3-hour and 24-hour SO_2 concentrations are presented due to the procedure used.

Subsection 5.3 presents the highest annual average PSD increment consumption for each year of the 5-year period.

5.1 3-Hour SO_2 Concentrations

Primary Baseline Areas

Highest projected 3-hour average SO_2 PSD increment consumption is presented in Table 5-1 for the primary PSD baseline areas and in Table 5-2 for the perimeter PSD baseline areas. The highest predicted

TABLE 5-1

HIGHEST 3-HOUR AVERAGE SO_2 PSD INCREMENT CONSUMPTION IN PRIMARY PSD BASELINE AREAS FROM SOURCES MODELED IN THIS STUDY

Year	Day	Hour Ending	Location	Concentration (μg/m3)	Category
1977	136	1200	Boston (Rec #142)	160.5	Highest
	136	1200	Boston (Rec #141)	115.1	Highest Second Highest
1978	275	1200	Boston (Rec #148)	115.4	Highest
	174	1200	Boston (Rec #141)	99.1	Highest Second Highest
1979	167	1200	Boston (Rec #141)	155.9	Highest
	185	1200	Boston (Rec #143)	103.9	Highest Second Highest
1980	127	0900	Boston (Rec #113)	181.2	Highest
	015	1500	Milton, Blue Hill (Rec #001)	122.2	Highest Second Highest
1981	146	1200	Boston (Rec #141)	146.1	Highest
	320	0300	Boston (Rec #025)	113.2	Highest Second Highest

Note: PSD increment for a 3-hour average = 512 $\mu g/m^3$

TABLE 5-2

HIGHEST 3-HOUR AVERAGE SO_2 PSD INCREMENT CONSUMPTION IN PERIMETER PSD BASELINE AREAS FROM SOURCES MODELED IN THIS STUDY

Year	Day	Hour Ending	Location	Concentration($\mu g/m^3$)	Increment Already Consumed ($\mu g/m^3$)	Total($\mu g/m^3$)
1977	262	0900	N. Andover	49.5	42.7	92.2
	193	1800	Methuen	36.2	35.0	71.2
	028	2100	Lawrence	27.0	115.0	142.0
	114	0600	Natick	48.5	199.7	248.2
1978	267	0900	N. Andover	44.0	42.7	86.7
	200	0900	Methuen	39.0	35.0	74.0
	168	0900	Lawrence	52.4	115.0	167.4
	145	0300	Natick	66.2	199.7	265.9
1979	112	0900	N. Andover	73.7*	42.7	116.4
	002	1800	Methuen	51.5*	35.0	86.5
	296	1800	Lawrence	43.1	115.0	158.1
	115	0900	Natick	73.9*	119.7	273.6
1980	190	1500	N. Andover	42.3	42.7	85.0
	326	0900	Methuen	44.7	35.0	79.7
	101	1800	Lawrence	59.3*	115.0	174.3
	210	1200	Natick	60.2	199.7	259.9
1981	032	2400	N. Andover	46.6	42.7	89.3
	050	1800	Methuen	27.0	35.0	62.0
	135	1500	Lawrence	46.5	115.0	161.5
	142	1500	Natick	72.7	199.7	222.4

Note: PSD increment for a 3-hour average = 512 $\mu g/m^3$.

*Highest 3-hour PSD increment consumption in this city/town for the 5-year modeling period.

value for the 5-year period is 181.2 μg/m^3. This concentration is predicted to occur in the vicinity of the Union Square area to the west of Boston proper. This value represents a 35% consumption of the SO_2 PSD increment of 512 μg/m^3. Meteorological conditions which would produce the 181.2 μg/m^3 impact consisted of 3.6-5.1 m/s winds accompanied by a slightly unstable to neutral atmosphere. The Mystic Station is most likely the largest contributor to the 181.2 μg/m^3 impact during this 3-hour period since it is directly upwind. The highest-second-highest modeled 3-hour SO_2 concentration is 122.2 ug/m^3. This value is predicted to occur under moderate to strong north-northeast winds (7-10 m/sec) at a receptor location on the Great Blue Hill in Milton. In summary, both the highest and the highest-second-highest modeled concentrations demonstrate that the 3-hour SO_2 PSD increment of 512 ug/m^3 will be maintained in the primary PSD baseling areas by a wide margin.

A list of 25 highest 3-hour SO_2 concentrations in primary baseline areas due to increment consuming emission increases is presented in Appendix G.

Perimeter Baseline Areas

The highest predicted 3-hour SO_2 increment consumption level in each perimeter PSD baseline area is presented in Table 5-2. Highest levels predicted in N. Andover, Methuen, Lawrence and Natick are 73.7, 51.5, 59.3, and 73.9 μg/m^3, respectively for the 5-year period. All predicted values are less than 15% of the 512 μg/m^3 SO_2 increment. Table 5-2 also lists the SO_2 increment already consumed by the triggering PSD baseline source. The addition of the already consumed level of increment to the highest predicted value over the 5-year period from this study results in the totals shown in the last column of Table 5-2. As indicated, the 3-hour 512 ug/m^3 increment will be safely maintained in each perimeter baseline area.

5.2 24-Hour SO_2 Concentrations

Primary Baseline Areas

Highest projected 24-hour average SO_2 PSD increment consumption is presented in Table 5-3 for the primary PSD baseline areas and in Table 5-4 for the perimeter PSD baseline areas. The highest value for the 5-year period in the primary PSD baseline area is 47.3 $\mu g/m^3$, which represents a 52% consumption of the 24-hour average PSD increment of 91 $\mu g/m^3$. This value is predicted to occur on Great Blue Hill in Milton on meteorological day 015 in 1980. Moderate to strong (7-10 m/s) north-northeast winds accompanied by neutral atmospheric stabilities would advect the New Boston plume toward Blue Hill on this type of meteorological day.

The highest-second-highest 24-hour PSD increment consumption in the primary PSD baseline region is 32.3 $\mu g/m^3$ which is 35% of the 91 $\mu g/m^3$ increment. This value is predicted to occur on day 017 during meteorological year 1980 on a Hancock Hill located 1.5 km NE of Great Blue Hill. Wind and stability regimes similar to meteorological day 015 (highest impact day) characterize day 017. In summary, both the highest and highest-second-highest modeled SO_2 concentrations demonstrate that the 24-hour SO_2 PSD incement of 91 ug/m^3 will be maintained in the primary PSD baseline areas by a wide margin.

Perimeter Baseline Areas

The highest predicted 24-hour average PSD increment consumption in the perimeter PSD baseline areas is presented in Table 5-4. Highest values predicted in N. Andover, Methuen, Lawrence and Natick are 18.1, 11.5, 15.9 and 20.0 $\mu g/m^3$, respectively for the 5-year period. Note that the value of 20.0 $\mu g/m^3$ in Natick does not include the contribution from Natick Paperboard. All predicted values are less than 22% of the 91 $\mu g/m^3$ PSD increment. Table 5-4 also lists the PSD increment already consumed by the triggering PSD baseline source for each area. The addition of these values to the highest predicted value for the 5-year period from this study results

TABLE 5-3

HIGHEST 24-HOUR AVERAGE SO_2 PSD INCREMENT CONSUMPTION IN PRIMARY PSD BASELINE AREAS FROM SOURCES MODELED IN THIS STUDY

Year	Day	Location (UTM)	Concentration (µg/m3)	Cagetory*
1977	287	Boston (Rec #082)	34.0	Highest
	353	Boston (Rec #082)	27.0	Highest Second Highest
1978	014	Hancock Hill, Milton (Rec #002)	41.1	Highest
	326	Hancock Hill, Milton (Rec #002)	26.6	Highest Second Highest
1979	057	Boston (Rec #082)	30.4	Highest
	224	Boston (Rec #082)	28.8	Highest Second Highest
1980	015	Great Blue Hill, Milton (Rec #001)	47.3	Highest
	017	Hancock Hill, Milton (Rec #002)	32.3	Highest Second Highest
1981	319	Boston (Rec #082)	34.5	Highest
	262	Hancock Hill, Milton (Rec #002)	28.7	Highest Second Highest

---

Note: PSD Increment for a 24-hour average = 91 $\mu g/m^3$.

TABLE 5-4

HIGHEST 24-HOUR AVERAGE SO_2 PSD INCREMENT CONSUMPTION IN PERIMETER PSD BASELINE AREAS FROM SOURCES MODELED IN THIS STUDY

Year	Day	Location	Concentration($\mu g/m^3$)	Increment Already Consumed ($\mu g/m^3$)	Total($\mu g/m^3$)
1977	269	N. Andover	8.5	19.0	27.5
	193	Methuen	7.6	15.6	23.2
	325	Lawrence	9.0	43.0	52.0
	114	Natick	15.2	79.0	94.2
1978	009	N. Andover	13.8	19.0	32.8
	128	Methuen	7.9	15.6	23.5
	008	Lawrence	9.5	43.0	52.5
	236	Natick	18.2	79.0	97.2
1979	147	N. Andover	18.1*	19.0	37.1
	117	Methuen	11.5*	15.6	27.1
	350	Lawrence	11.3	43.0	54.3
	060	Natick	20.0*	79.0	99.0
1980	243	N. Andover	6.5	19.0	25.5
	101	Methuen	10.1	15.6	25.7
	101	Lawrence	8.2	43.0	51.2
	119	Natick	15.8	79.0	94.8
1981	033	N. Andover	18.0	19.0	37.0
	135	Methuen	6.7	15.6	22.3
	135	Lawrence	15.9*	43.0	58.9
	142	Natick	16.7	79.0	95.7

Note: PSD increment for a 24-hour average = 91 $\mu g/m^3$.

* Highest 24-hour PSD increment consumption in this city/town for the 5-year modeling period.

in the totals shown in last column of Table 5-4. As shown by these totals, the 91 ug/m^3 will be maintained in N. Andover, Methuen, and Lawrence. A total greater than 91 ug/m^3 is listed for Natick. However, this does not mean that the 91 ug/m^3 increment will be violated. It means that further detailed modeling for additional receptors in Natick is required. This additional modeling was performed for 6 additional receptors which capture the interaction among the candidate Edison units and Natick Paperboard, the PSD source triggering the baseline in Natick. A seventh receptor was placed at the location of Natick Paperboard's maximum predicted PSD increment consumption of 79 μg/m^3 (Walnut Hill). This was done in order to calculate a realistic maximum expected PSD increment consumption at that point for comparison with totals in the last column of Table 5-4. The results for this additional modeling for Natick are presented in Table 5-5. As indicated, compliance with the 91 ug/m^3 increment would be maintained if Natick Paperboard were to interact with the coal-fired candidate units. The highest predicted level of increment consumption during such a potential interaction is 26.2 ug/m^3. During periods of high impact from Natick Paperboard, the maximum concentration is 88.2 μg/m^3. This value is predicted to occur on Walnut Hill during meteorological year 1981 on day 351. The highest-second-highest concentration over the 5-year period is 75.6 μg/m^3. This value is predicted to occur during meteorological year 1977. Both values are due solely to impact from Natick Paperboard without contribution from the candidate units as winds on these days were from the WSW. Clearly the candidate Edison units do not interact with Natick Paperboard when Natick Paperboard emissions have their maximum ambient effect. The addition of 79 μg/m^3 due to Natick Paperboard (already consumed increment) to the 20 μg/m^3 calculated for the increment consuming emission increases (Table 5-4, day 060, 1979) considered in this study is too conservative because each maximum was simulated to occur during different meteorological events and thus would not occur simultaneously. The concentration presented in Table 5-5 represents the highest level of consumed increment for Natick Paper Board and all other interacting increment consuming sources during coincident meteorological events.

TABLE 5-5

HIGHEST 24-HOUR AVERAGE SO_2 PSD INCREMENT CONSUMPTION RESULTING FROM INTERACTION OF MYSTIC AND NEW BOSTON WITH NATICK PAPERBOARD

Year	Day	Location with Respect to Natick Paperboard	Interaction	Total Concentration ($\mu g/m^3$)
1977	114	1.0 km SW	Mystic/N. Paper	19.7
	222	0.6 km WSW	New Boston/N. Paper	15.9
	336	0.8 km ENE	N. Paper Max Impact (No Interaction)	84.6 (75.6)*
1978	236	1.0 km SW	Mystic/N. Paper	23.9
	236	0.8 km WSW	New Boston/N. Paper	20.3
	357	0.8 km ENE	N. Paper Max Impact (No Interaction)	61.2
1979	060	1.0 km SW	Mystic/N. Paper	26.2
	128	0.8 km WSW	New Boston/N. Paper	21.3
	166	0.8 km ENE	N. Paper Max Impact (No Interaction)	62.6
1980	119	1.0 km SW	Mystic/N. Paper	20.9
	127	0.8 km WSW	New Boston/N. Paper	18.5
	205	0.8 km ENE	N. Paper Max Impact (No Interaction)	71.9
1981	142	1.0 km SW	Mystic/N. Paper	21.2
	142	0.6 km WSW	New Boston/N. Paper	18.8
	351	0.8 km ENE	N. Paper Max Impact (No Interaction)	88.2

Note: PSD increment for a 24-hour average = 91 $\mu g/m^3$.

*Highest-second-highest concentration at Walnut Hill over the 5-year period.

5.3 Annual Average PSD Increment Consumption

Table 5-6 and 5-7 present highest annual average PSD increment consumption for the primary PSD baseline areas and the perimeter PSD baseline areas, respectively. In the primary areas, highest annual average increment consumption is predicted to occur in Milton during meteorological year 1980. The value of 1.46 $\mu g/m^3$ is predicted to occur approximately 2 km SE of Diamond International. The proximity of that source to the receptor strongly suggests that Diamond International is the major contributor to this receptor. The highest annual average PSD increment consumption in Boston for the five year period is a 0.99 $\mu g/m^3$. This value is predicted to occur in Boston Harbor approximately 19 km ENE of the New Boston station and 22 km ESE of Mystic.

Most values of annual average PSD increment consumption in the 166 receptor grid are negative. Figure 5-1 shows the pattern of annual average PSD increment consumption in the primary PSD baseline areas for a typical year (1981). The negative values of PSD increment consumption are the result of netting the larger negative impacts from the five baseline sources (see Table 3-2) with the positive contributions due to coal firing. Although the emissions from the baseline sources are lower than the increase from these same units after converting to coal, the magnitude of the baseline contributions are generally greater than the magnitude of the coal fired contributions. Since the baseline contributions are negative they often overcompensate for the positive coal contributions and thus negative values of increment consumption are netted.

Perimeter Baseline Areas

Table 5-7 presents highest annual average PSD increment consumption in the perimeter PSD baseline areas. All impacts are less than the 1.0 $\mu g/m^3$ significance level. The highest impact of 0.5 $\mu g/m^3$ was predicted to occur in N. Andover for meteorological year 1979. The addition of the highest predicted values from this

TABLE 5-6

HIGHEST ANNUAL AVERAGE PSD INCREMENT CONSUMPTION IN PRIMARY PSD BASELINE AREAS FROM SOURCES MODELED IN THIS STUDY

Year	Location	Concentration (μg/m3)
1977	Boston-Milton Boundary (Rec #006)	1.45
1978	Boston Harbor (Rec #125)	0.99
1979	Boston Harbor (Rec #125)	0.77
1980	Boston-Milton Boundary (Rec #006)	1.46
1981	Boston-Milton Boundary (Rec #006)	1.12

Note: PSD Increment for annual average = 20 μg/m^3.

TABLE 5-7

HIGHEST ANNUAL AVERAGE SO_2 PSD INCREMENT CONSUMPTION IN PERIMETER PSD BASELINE AREAS FROM SOURCES MODELED IN THIS STUDY

Year	Location	Concentration(μg/m^3)	Increment Already Consumed (μg/m^3)	Total(μg/m^3)
1977	N. Andover	-0.2	1.8	1.6
	Methuen	0.1	1.4	1.5
	Lawrence	0.1	9.2	9.3
	Natick	0.3	8.0	8.3
1978	N. Andover	0.1	1.8	1.9
	Methuen	0.1	1.4	1.5
	Lawrence	0.1	9.2	9.3
	Natick	0.2	8.0	8.2
1979	N. Andover	0.5	1.8	2.3
	Methuen	0.2	1.4	1.6
	Lawrence	0.2	9.2	9.4
	Natick	0.4	8.0	8.4
1980	N. Andover	-0.1	1.8	1.7
	Methuen	0.1	1.4	1.5
	Lawrence	0.1	9.2	9.3
	Natick	0.1	8.0	8.1
1981	N. Andover	0.4	1.8	2.2
	Methuen	0.2	1.4	1.6
	Lawrence	0.3	9.2	9.5
	Natick	0.1	8.0	8.1

Note: PSD increment for a annual average = 20 μg/m^3.

study to the annual average PSD increment already consumed in these perimeter cities and towns results in the totals listed in the last column of Table 5-7.

All totals are well below the annual PSD increment of 20 $\mu g/m^3$.

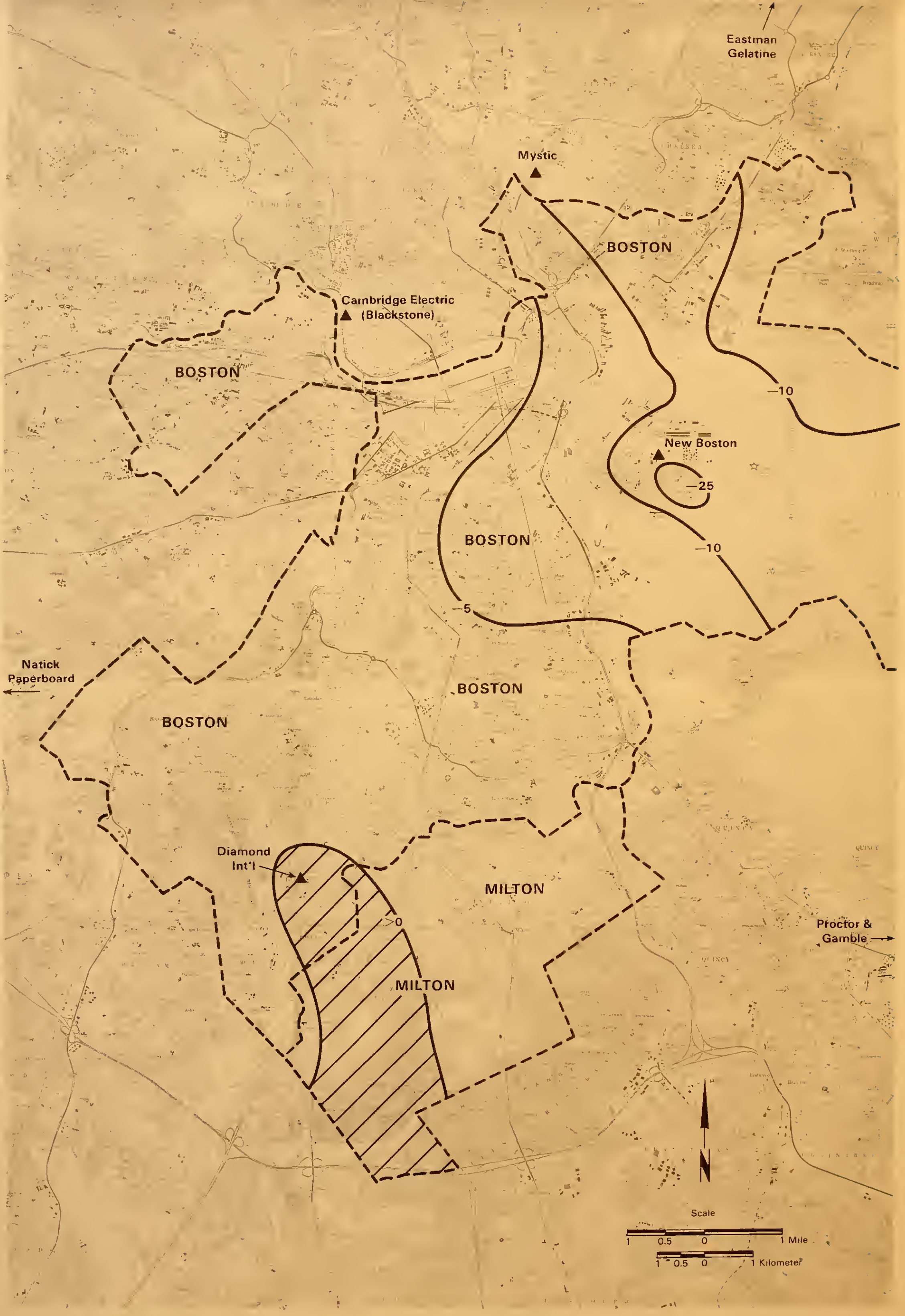


Figure 5-1 Annual Average SO_2 PSD Increment Consumption (Meteorological Year: 1981)

APPENDIX A

DESCRIPTION OF THE ISC MODEL

APPENDIX A

DESCRIPTION OF THE ISC MODEL

A.1 Meteorological Preprocessing Procedures

Stability categories A through G were determined by the widely accepted classification scheme suggested by Bruce Turner (1964). This technique, which is derived chiefly from earlier experimental work by Frank Pasquill (1961), defines stability near the ground in terms of net solar radiation and wind speed. During the day, hourly observations of cloud cover and ceiling height may be combined with the local solar altitude, determined from astronomical tables, to characterize surface insolation. At night, the net radiation is negative (outgoing), and the cloud cover and ceiling height again provide a basis for determining a "radiation index." By means of the Turner-based stability classification, five to seven stability classes can be evaluated depending on the desired degree of resolution of stable atmospheric conditions. Each Turner stability class corresponds to specific radiation-wind speed combinations that have been empirically associated with a degree of atmospheric mixing capacity. Table A-1 presents the Turner-based atmospheric stability classification system (Turner 1969).

ISC incorporates wind speed and wind direction as recorded at the NWS meteorological measurement station. For this study, the measurements of surface data were from Logan International Airport for the years 1977 through 1981. The hourly wind flow vectors are modified by the meteorological preprocessor program to represent wind direction fluctuations. This is handled by the standard EPA random number file. For each hour of each day, a random number from 0 to 9 is assigned. This number is added to the flow vector and 4 is subtracted from the total. The resultant randomization flow vector will be within -4° to +5° of the reported flow vector. For example, if on day 1 the first 10 hours reported a 90° flow vector, the randomized flow vector used for modeling would be as follows:

TABLE A-1

A GENERAL KEY TO THE TURNER STABILITY CLASSIFICATION SYSTEM

Surface Wind (meters per second)	Day			Night	
	Incoming Solar Radiation				
	Strong	Moderate	Slight	≤3/8 Cloud	Thin Overcast** <4/8 Low Cloud
<2	A*	A-B	B	G	F
2-3	A-B	B	C	F	E
3-5	B	B-C	C	E	D
5-6	C	C-D	D	D	D
>6	C	D	D	D	D

---

*A - Extremely unstable

B - Moderately unstable

C - Slightly unstable

D - Neutral

E - Slightly stable

F - Moderately stable

G - Extremely stable

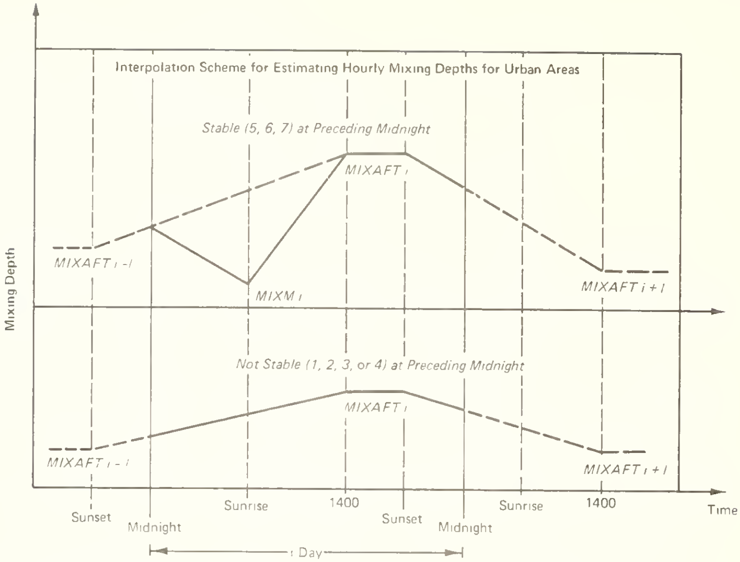
**Neutral conditions assumed for all overcast conditions.

Hour	Flow Vector	Randomized Flow Vector
1	90	91
2	90	88
3	90	94
4	90	93
5	90	93
6	90	92
7	90	95
8	90	93
9	90	87
10	90	91

ISC also considers the mixing depth as interpolated by the EPA scheme (EPA 1974). There are two EPA schemes, one for rural surroundings and one for urban areas. Both schemes involve the use of radiosonde data from upper air measurements, which are usually taken twice per day at NWS upper air stations. For this study, the upper air measurements for the years 1977 through 1981 from the Portland, Maine radiosonde station were used as the basis for the hourly mixing depths.

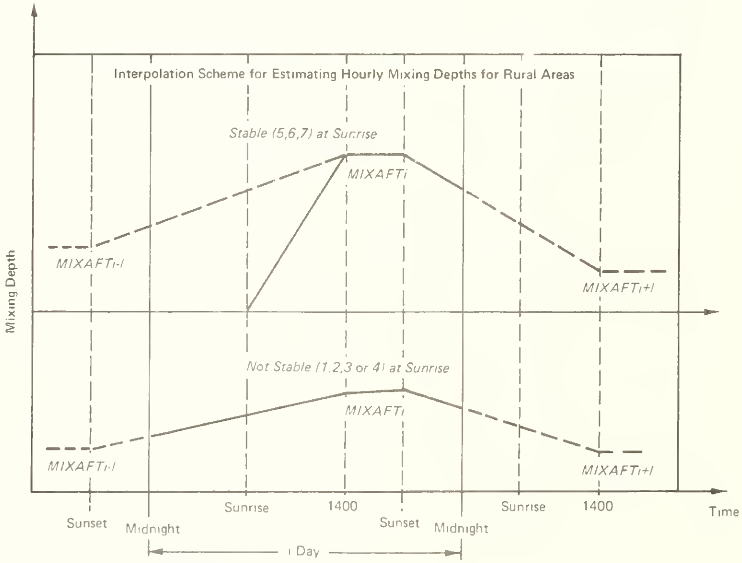
The techniques by which hourly mixing depths are determined are exemplified in Figures 1(a) and 1(b). The inputs to these schemes are the morning (minimum) mixing depth, MIXM, and afternoon (maximum) mixing depth, MIXAFT, for the current day, i; the previous day, i-1; and the following day, i+1. The scheme is as follows.

The urban mixing depth scheme is keyed to the stability at midnight and employs morning and afternoon mixing heights. To determine mixing depths between midnight and sunrise if the stability is other than stable at midnight, interpolate between $MIXAFT_{i-1}$ and $MIXAFT_i$. If the stability at midnight is stable, interpolate between $MIXAFT_{i-1}$ and $MIXM_i$. For hours between sunrise and 1400, if the stability at midnight is other than stable, interpolate between $MIXAFT_{i-1}$ and $MIXAFT_i$. For sunrise to 1400, if the stability at midnight is stable, interpolate between $MIXM_i$ and $MIXAFT_i$. For


Interpolation Scheme for Estimating Hourly Mixing Depths for Urban Areas
Stable (5, 6, 7) at Preceding Midnight
MIXAFT i
MIXAFT i -l
MIXM i
MIXAFT i + l
Not Stable (1, 2, 3, or 4) at Preceding Midnight
MIXAFT i
MIXAFT i - l
MIXAFT i + l
Mixing Depth
Sunset
Midnight
Sunrise
1400
Sunset
Midnight
Sunrise
1400
Time
i Day

MIXM = Morning (Minimum) Mixing Depth
MIXAFT = Afternoon (Maximum) Mixing Depth
i = Current Day
i-1 = Previous Day
i+1 = Following Day

(a) Urban Areas


Interpolation Scheme for Estimating Hourly Mixing Depths for Rural Areas
Stable (5,6,7) at Sunrise
MIXAFTi
MIXAFTi-l
MIXAFTi+l
Not Stable (1,2,3 or 4) at Sunrise
MIXAFTi
MIXAFTi-l
MIXAFTi+l
Mixing Depth
Sunset
Midnight
Sunrise
1400
Sunset
Midnight
Sunrise
1400
Time
i Day

MIXAFT Afternoon (Maximum) Mixing Depth
i = Current Day
i-l = Previous Day
i+l = Following Day

808065

(b) Rural Areas

Figure 1 Interpolation Scheme for Determining Hourly Mixing Depths for Urban and Rural Areas

1400 to sunset, use MIXAFT_i. For hours between sunset and midnight, interpolate between MIXAFT_i and MIXAFT_{i+1}.

For rural mixing heights between midnight and sunrise, interpolate between MIXAFT_{i-1} and MIXAFT_i. For hours between sunrise and 1400, if the stability at sunrise is other than stable, interpolate between MIXAFT_{i-1} and MIXAFT_i. If the stability at sunrise is stable, interpolate between 0 and MIXAFT_2. For 1400 to sunset, use MIXAFT_i. For hours between sunset and midnight, interpolate between MIXAFT and MIXAFT_{i+1}. In this study, the urban mixing depth scheme was used.

A.2 Techniques of the ISC Model

When exhaust gases from a source are vented through a stack that is shorter than the calculated Good Engineering Practice (GEP) height the aerodynamic turbulence induced by a building may cause pollutants emitted from the stack to be mixed rapidly toward the ground. This situation, known as building downwash, would result in higher ground level concentrations immediately in the lee of the building than would otherwise occur under normal dispersion conditions.

A.2.1 Enhancement of the Dispersion Coefficients

The model used was based on the techniques developed by Huber (1977, 1979). This method consisted of modifying the dispersion parameters in the standard Gaussian dispersion model. These modifications were based on results of wind tunnel studies (Huber and Snyder 1976) and are functions of building width and building height. These functional relationships are given by:

$$\sigma_y{}'(x) = 0.7\ Hw/2 + 0.067\ (x-3Hb) \text{ for } 3Hb<x<10Hb \qquad (1a)$$

$$\sigma_y{}'(x) = \sigma_y\{x+Sy\} \text{ for } x\geq 10Hb \qquad (1b)$$

$$\sigma_z{}'(x) = 0.7Hb + 0.067\ (x-3Hb) \text{ for } 3Hb<x<10Hb \qquad (1c)$$

$$\sigma_z{}'(x) = \sigma_z\{x+Sz\} \text{ for } x\geq 10Hb \qquad (1d)$$

where:

Hw/2 is the "half-width" of the region of influential buildings normal to the wind (m),

Hb is the height of the highest influential building (m),

Sy is the virtual source distance (m) such that $\sigma_y'(10Hb) = 0.7\ Hw/2 + 0.5Hb$,

Sz is the virtual source distance (m) such that $\sigma_z'(10Hb) = 1.2\ Hb$,

x is the downwind distance from the building edge (m),

σ_y, σ_z are the values of the horizontal and vertical dispersion parameters in the absence of building structures (m).

For a tall building, Huber (1977) suggests that the width scale Hw replace Hb in Equations 1c and 1d. For a building that is much wider than it is tall and a stack located toward the center of the building (i.e., away from either end), Huber believes that only the height scale is significant. Under these circumstances, Hb will replace Hw in Equation 1a.

Huber (1977) states that if the unmodified dispersion parameters are greater than what his method calculates, then no modification is made. He found that, except for some locations very close to the building, no modification for very unstable (P-G stability A or B) atmospheric conditions was needed.

Huber also states that no modification is made to the horizontal dispersion parameter, σ_y, if the source effective height (at two building heights downwind) is greater than 1.2 times the building height (Huber 1977).

A.2.2 Wind Speed Correction with Height

The wind speed at stack top is determined from the surface wind speed by the well known power law relationship:

$$u\,(h) = u_o \left(\frac{h}{z_r}\right)^{p} \qquad (2\text{-a})$$

where

u_o is the surface wind speed (m/s),

h is the stack height,

z_r is the reference height at which the surface wind speed was measured (assumed to be 10 m), and

p is the wind profile exponent (.15, .15, .20, .25, .30, .30 for stability classes A through F) DeMarrais 1959.

A.2.3 Plume Rise

Briggs' (1975) plume rise equation for stability classes A through D is given in Equation 3a. To determine if downwash is expected to occur, the plume rise due solely to momentum is calculated at a downwind distance equal to two building heights (2Hb) downwind. Equation 3a would then simplify to the first term since F would equal zero for nonbuoyant plumes.

$$\Delta h = \left[\frac{3\ Fm\ x'}{\beta_j^{2}\ u^{2}} + \frac{3Fx'^{2}}{2\beta_1^{2}\ u^{3}}\right]^{1/3} \qquad (3a)$$

where

F is the buoyancy flux,

$$F = g \frac{Vsd^2}{4} \quad 1-\frac{Ta}{Ts}$$

F_m is the momentum flux,

$$F_m = \frac{(Ta/Ts)\ Vs^2 d^2}{4}$$

β_j is the jet entrainment coefficient,

$$\beta_j = \left(\frac{1}{3} + \frac{u}{Vs}\right)$$

T_a is the ambient temperature, °K

T_s is the stack gas temperature, °K

V_s is the exit velocity, m/s

d is the stack inside diameter, m

g is acceleration due to gravity, 9.8 m/s^2

u is the wind speed at stack height, (m/s)

β_1 equals .6 (Briggs 1975)

x' is the downwind distance, or in the determination of building downwash influence x' is equal to $2H_b$.

x' is defined as follows:

$$\text{let } \alpha = \frac{4d\ (Vs + 3u)^2}{Vs\ u}$$

$$x' = \begin{array}{rl} x & ;\ \text{if } x < 3.5\ x^* \text{ and } F > 0 \\ 3.5\ x^* & ;\ \text{if } x \geq 3.5\ x^* \text{ and } F > 0 \\ x & ;\ \text{if } x < \alpha \text{ and } F = 0 \\ & ;\ \text{if } x \geq \alpha \text{ and } F = 0 \end{array}$$

where

$$x^* = \begin{array}{l} 14F^{5/8};\ F \leq 55\ m^4/s^3 \\ 34\ F^{2/5};\ F > 55\ m^4/s^3 \end{array}$$

For stability classes E and F the Briggs (1975) plume rise equation is:

$$\Delta h = \left[\frac{3Fm}{\beta_j^2\ u\ S^{1/2}} \sin\left(S^{1/2}\ \frac{x'}{u}\right) + \frac{3F}{\beta_2^2\ u\ S} \left(1-\cos\left(S^{1/2}\ \frac{x'}{u}\right)\right) \right]^{1/3} \qquad (3b)$$

where

S is the stability parameter

$$S = \frac{g}{Ta}\ \frac{d\theta}{dz}$$

$\frac{d\theta}{dz}$ is potential temperature gradient (.020 for Class E and .035 for Class F)

β_2 equals .6 (Briggs 1975)

x' is defined as follows

let $C = \pi u\ S^{-1/2}$

$$x' = \begin{array}{l} x\ ;\ \text{if } x < C \text{ and } F > 0 \\ C\ ;\ \text{if } x \geq C \text{ and } F > 0 \\ x\ ;\ \text{if } x < C/2 \text{ and } F = 0 \\ C/2\ ;\ \text{if } x \geq C/2 \text{ and } F = 0 \end{array}$$

If F = 0 and the plume rise, Δh is greater than $(3V_s\ d)/u$ then the ISC model sets Δh to $(3V_s\ d)/u$.

The initial effective plume height at two building heights downwind is:

$$H' = h + \Delta hm \qquad (3c)$$

where

h = stack height, m
Δhm = momentum plume rise, m

H' is used in the ratio H'/H_b to determine whether σ_y and σ_z are enhanced due to building wake influences. The effective plume height (H) used in the calculation of concentration is the sum of the stack height and the plume rise due to momentum and buoyancy.

A.2.4 Concentration Equation

The calculation of ground level concentration is given in Equation 4.

$$\chi = \frac{Q(10^6)}{\pi\ u\ \sigma'_y\ \sigma'_z} \exp\left[-\frac{1}{2}\left(\frac{Y}{\sigma'_y}\right)^2\right] \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma'_z}\right)^2\right]$$

$$+ \sum_{N=1}^{N=\infty} \exp\left[-\frac{1}{2}\left(\frac{H-2NL}{\sigma'_z}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{H+2NL}{\sigma'_z}\right)^2\right] \qquad (4)$$

where

Q is emission rate, g/s
u is wind speed at stack height, m/s
σ_y' ,σ_z' are horizontal and vertical dispersion coefficients, the larger of each σ_y and σ_y and σ_z' and σ_z are used
Y is crosswind distance, m
H is effective plume height, m
L is mixing depth, m

A.2.5 Terrain Influences

The original ISC model employs the technique used in CRSTER (EPA 1977), to calculate the effect of terrain influences on plant impacts. Specifically, when a receptor height is above the stack base elevation the receptor height is subtracted from the plume height. For a receptor height less than the stack base elevation no adjustment to the plume height is made. To apply this technique all receptor heights must be less than the stack heights used in the model.

The modified version of ISC used in this study cuts off terrain just below stack top elevation on a stack-by-stack basis, thus allowing sources of varying stack heights to be modeled together. In the unmodified version of ISC, the user would have to truncate terrain at the lowest stack top elevation or make multiple runs. EPA Region I staff made the coding changes and these were implemented by ERT on ERT's computer. EPA Region I's test cases were duplicated in order to ensure that no errors had been made in implementing Region I's changes. Results of the test case runs were sent to EPA Region I and approved by them.

REFERENCES

Briggs, G. A. 1975. Plume Rise and Prediction. *Lectures on Air Pollution and Environmental Impact Analysis*. Boston: American Meteorological Society.

DeMarrais, G. A. 1959. "Wind Speed Profiles at Brookhaven National Laboratory," Journal of Applied Meteorology, 16:181.

EPA 1977. *User's Manual for Single-Source (CRSTER) Model*. Publication No. EPA 450/2/77-013. Environmental Protection Agency.

EPA 1974. Applying Atmospheric Simulation Models to Air Quality Maintenance Area. *Guidelines for Air Quality Maintenance Planning and Analysis 12*. Publication No. OAQPS 1.2-031, EPA-450/474013. Environmental Protection Agency.

Huber, A. 1977. Incorporating Building/Terrain Wake Effects on Stack Effluents. Preprints of the AMS-APCA Joint Conference on Applications of Air Pollution Meteorology, Salt Lake City, UT, November.

Huber, A. 1979. An Evaluation of Obstacle Wake Effects on Plume Dispersion. Preprints of the AMS Fourth Symposium on Turbulence, Diffusion, and Air Pollution, Reno, NV.

Huber, A. and A. Snyder 1976. Building Wake Effects on Short Stack Effluents. Preprints of the AMS Third Symposium on Atmospheric Turbulence, Diffusion, and Air Quality, Raleigh, NC.

Pasquill, F. 1961. *Atmospheric Diffusion*. London: Van Nostrand Press.

Turner, D. B. 1964. A Diffusion Model for an Urban Area. *J. Appl. Met*. *2*:83-91.

Turner, D. B. 1969. *Workbook of Atmospheric Dispersion Estimates*. PHS Publication No. 999-AP-26, Environmental Protection Agency, Research Triangle Park, NC.

APPENDIX B

DETERMINATION OF GEP STACK HEIGHT FOR BOSTON EDISON'S MYSTIC AND NEW BOSTON STATIONS

APPENDIX B

DETERMINATION OF GEP STACK HEIGHT FOR BOSTON EDISON'S MYSTIC AND NEW BOSTON STATIONS

B.1. Determination of GEP Stack Height for the New Boston Station

Good Engineering Practice (GEP) stack height is defined as "the height necessary to ensure that emissions from the stack do not result in excessive concentrations of any air pollutant in the immediate vicinity of the source as a result of atmospheric downwash, eddies, and wakes which may be created by the source itself, nearby structures or nearby terrain obstacles" (EPA, 1981). Building a stack at or near GEP stack height will help to minimize the potential ground-level impacts of effluents released from the stack.

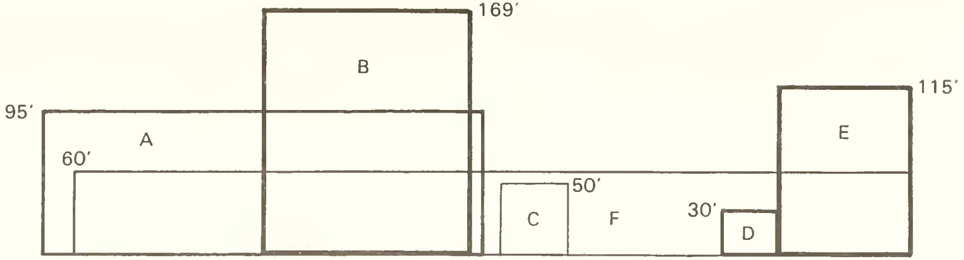
Figure B-1 contains side and top views of the New Boston and L Street buildings after the proposed conversion to coal. The building dimensions are estimates obtained from plot plans provided by Boston Edison. For a multi-tiered structure such as this, the GEP stack height is the maximum of the GEP stack heights as determined from the individual tiers. The recommended empirical rule for determining GEP stack height is:

$$H_{GEP} = H_B + 1.5 \text{ minimum } [H_B, L_d] \qquad (1)$$

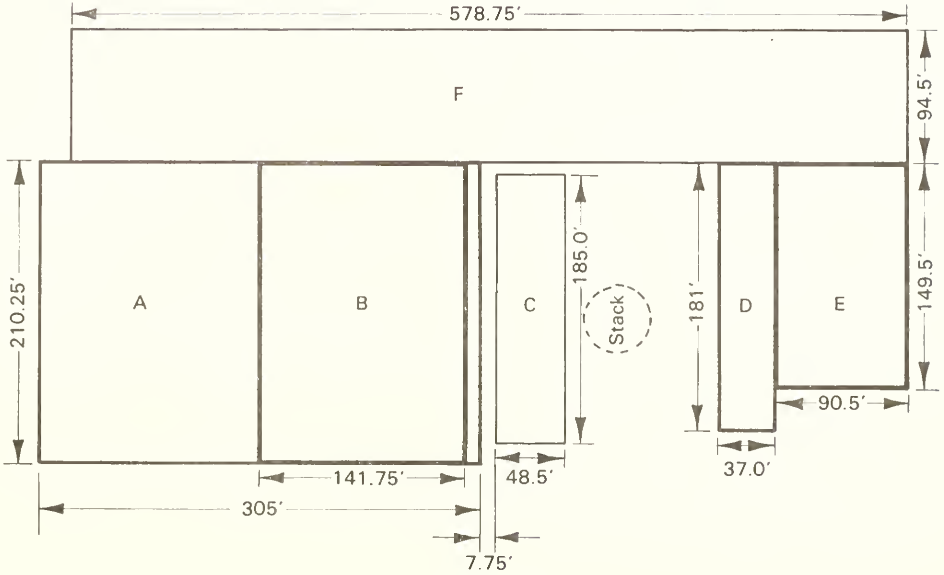
where

H_{GEP} is GEP stack height,
H_B is the building height, and
L_d is the maximum horizontal building dimension.

Table B-1 contains the solution of Equation 1 for each of the six building tiers. The horizontal dimensions of each tier in Table B-1 are the largest horizontal dimensions (length and width) of any building structure or structures with a height at or above the particular tier height. For example, although building C in Figure B-1 has horizontal dimensions 48.5' x 185.0', the appropriate tier C dimensions in the GEP calculation are (48.5' + 7.75' + 305') x 185', because the adjacent building A is higher than building C. If,



(a) Side View



(b) Top View

Figure B-1 Proposed New Boston/L Street Building Configuration

TABLE B-1

GEP STACK HEIGHT CALCULATIONS FOR THE PROPOSED SIX-TIERED NEW BOSTON STATION

Tier	Length (ft)	Width, w (ft)	Diagonal, L_d (ft)	Height, HB (ft)	HB+1.5 Min (HB,L_d) (ft)
A	305.00	210.3	370.5	95.0	237.5
B	141.8	210.3	253.5	169.0	422.5
C	361.3	185.0	405.8	50.0	125.0
D	127.5	275.5	303.6	30.0	75.0
E	90.5	149.5	174.8	115.0	287.5
F	578.8	244.0	628.0	60.0	150.0

as in this example, the buildings are separated, the gap is treated as if it were filled by a structure equal in height to the lesser of the two heights as long as the gap is less than the projected dimension (height or width) of either building (EPA 1981). From Table B-1, it can be seen that the controlling tier is Tier B with horizontal dimensions of 141.75' x 210.25' and a 169' height. The GEP stack height based on tier B is 422.5'. Thus, to avoid all building downwash effects, a stack height of 422.5' is necessary. However, due to the proximity of the New Boston/L Street station to Logan International Airport, the New Boston stack height is limited to 372', the same height as the MBTA stack which is closer to Logan.

B.2 Determination of GEP Stack Height for the Mystic Station

A GEP stack height analysis was performed to determine appropriate GEP stack heights for the four stacks at Boston Edison's Mystic Generating Station. The stack height calculation was performed using criteria in the Guideline for Determination of Good Engineering Practice Stack Height (EPA 1981).

At the Boston Edison Mystic Generating Station, two building structures were considered in the determination of appropriate GEP stack heights for the four existing stacks. Figure B-2 presents the building dimensions and locations of these buildings relative to the four stacks (Units 4, 5, 6, and 7). Equation 1 (mentioned previously) was used to calculate GEP heights.

Based on the criteria set forth in the EPA Guideline Document, an appropriate GEP stack height was calculated for each stack assuming the taller building as the controlling structure. The results are presented in Table B-2. The actual GEP stack heights for units 4, 5, 6, and 7 would be 505, 521, 521, and 500 feet, respectively.

Since each stack would be in the zone of influence of the building wake created by the taller building under different wind direction conditions, the width of the frontal area of the structure projected onto a plane perpendicular to the direction of the wind would vary. As a result, the calculated GEP heights differ slightly for each stack since, in all cases, the building width was less than the building height (see Equation 1).

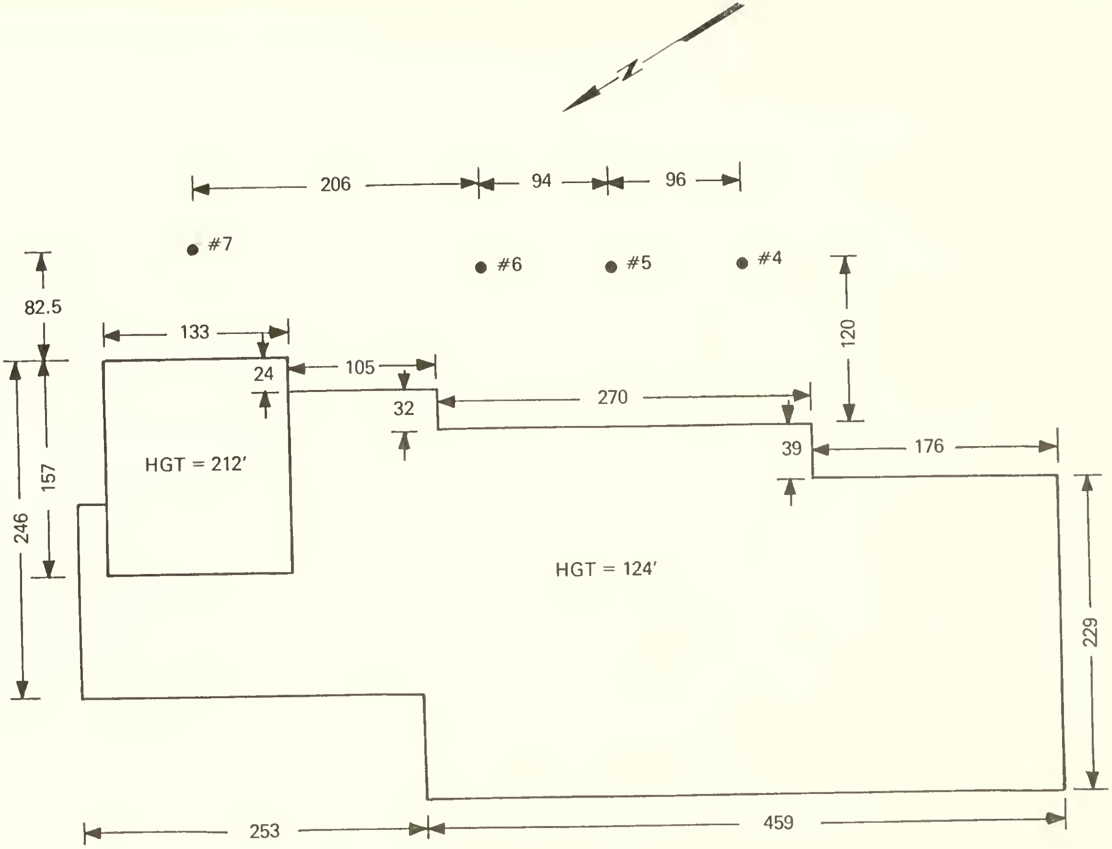


Figure B-2 Building Dimensions at the Mystic Generating Station

TABLE B-2

CALCULATED GEP STACK HEIGHTS FOR THE CONTROLLING STRUCTURE AT BOSTON EDISON's MYSTIC STATION

Controlling Structure Height	GEP Stack Heights (ft)			
	Mystic 4	Mystic 5	Mystic 6	Mystic 7
212'	505	521	521	500

REFERENCES

EPA 1981. Guideline for Determination of Good Engineering Practice Stack Height, Publication No. EPA 450/4-80-023, U.S. EPA, Research Triangle Park, NC 27111, July.

APPENDIX C

WORST-CASE LOAD ASSESSMENT FOR MYSTIC AND NEW BOSTON STATIONS

APPENDIX C

WORST-CASE LOAD ASSESSMENT FOR MYSTIC AND NEW BOSTON STATIONS

Introduction

Prior to the ISC sequential modeling, several different emission configurations at Mystic and New Boston were assessed using worst-case models to determine which configuration produces highest ambient impacts. The worst-case configuration at each station was then used in the sequential modeling. Tables C-1 and C-2 present the configurations and associated emission parameters for Mystic and New Boston, respectively. In general, the Mystic and New Boston units operate at highest efficiencies at or near 100% load. Under actual conditions, Mystic 7 will generally operate at full load while one or more of the other Mystic units will be either at full load or off line depending upon power requirements. At New Boston, if a particular unit is not needed it will be taken off line or maintained at minimum load. The modeling configurations for Mystic and New Boston are based on these likely generating conditions with the exception of the third New Boston case. This configuration, in which Unit I is at 50% load and unit 2 is off-line, occurs rarely and was modeled only for comparison with other configurations.

Methodology

Mystic Station

EPA's PTPLU and PTMTPA models were used in the worst-case assessment. PTPLU is designed to provide the maximum concentration and distance to that concentration for each meteorological condition and each stack modeled. The model computes single source impacts for a wide range of meteorological conditions. Model options used in this study include an ambient air temperature of 283°K and wind profile exponents of 0.15, 0.15, 0.20, 0.25, 0.30, 0.30 for stabilities A through F, respectively. PTPLU was used to model all Mystic units at

TABLE C-1

BOSTON EDISON SO_2 EMISSION PARAMETERS FOR THE MYSTIC STATION

Fuel	Unit	Stack Height (m)	Stack Temperature (°K)	Exit Velocity (m/sec.)	Equivalent Diameter (m)	SO_2 (g/s)	Configuration
1.5% S Coal	4, 5, 6	152.4	400.0	35.7	5.54	1421.0	4,5,6,7 at 100% load
2.2% S Oil	7	152.4	463.7	27.5	5.8 (actual)	1674.0	
1.5% S Coal	4, 5, 6	152.4	400.0	35.2	4.53	934.0	4, 5 at 100% load 6 off line 7 at 100% load
2.2% S Oil	7	152.4	463.7	27.5	5.8 (actual)	1674.0	
1.5% S Coal	4, 5, 6	152.4	400.0	35.2	3.20	46.70	5, 6 off line 4 at 100% load 7 at 100% load
2.2% S Oil	7	152.4	463.7	27.5	5.8 (actual)	1674.0	
1.5% S Coal	4, 5, 6	152.4	383.0	20.95	3.2	267.0	6 at 50% load 4, 5 off line 7 at 100% load
2.2% S Oil	7	152.4	463.7	27.5	5.8 (actual)	1674.0	

TABLE C-2

BOSTON EDISON SO_2 EMISSION PARAMETERS FOR THE NEW BOSTON STATION

Fuel	Unit	Stack Height (m)	Stack Temperature (°K)	Exit Velocity (m/sec.)	Equivalent Diameter (m)	SO_2 (g/s)	Configuration
1.5% S Coal	1	113.4	398.4	32.75	6.08	1438.0	Unit 1 at 100% load Unit 2 at 100% load
1.5% S Coal	2						
1.5% S Coal	1	113.4	392.3	28.5	5.65	1195.0	Unit 1 at 100% load Unit 2 at minimum load
1.5% S Coal	2						
1.5% S Coal	1	113.4	383.0	21.3	4.3	580.5	Unit 1 at 50% load Unit 2 off
1.5% S Coal	2						

100% load in order to determine the maximum receptor distances for the ensuing PTMTPA modeling. PTMTPA was then used in the worst-case load assessment because it is a multisource model which can predict combined impacts from both Mystic's proposed stacks. PTPLU does not have this capability. PTMTPA is an EPA Region I modified version of the UNAMAP model PTMTP. Modifications include the ability to account for an exponential wind speed increase with height (as does PTPLU), and a plane displacement topographic adjustment. PTMTPA was employed in this study using the same wind exponents as PTPLU. However, terrain was not considered since the terrain heights in the Boston area are not high enough to have a significant effect on the choice of worst-case load, i.e., modeled impacts at elevated receptor points would be slightly higher for all emission configurations but the configuration producing the highest impacts would be the same. Terrain heights were input to the sequential ISC modelng, however, in order to ensure conservative results.

PTMTPA was employed using a range of meteorological conditions and downwind distances. Limits on the latter were derived from the PTPLU modeling. Table C-3 lists the meteorology and receptor distances chosen for PTMTPA. PTMTPA and PTPLU calculate source impacts which are considered to be representative of 1-hour averaging times. Ambient standards for SO_2 have been set for 3- and 24-hour averaging periods. Since the worst-case load assessment is not intended for comparison with standards, only 1-hour average concentrations are presented. Maximum three and 24-hour concentrations from sequential ISC modeling are presented in the main body of this study, however.

The choice of worst-case load for the Mystic Station was made in the following way. The highest predicted impacts from both Mystic units using PTMTPA were tabulated for each meteorological condition tested and for each emission configuration listed in Table C-1. The emission configuration which produced the highest impacts was then chosen as the worst-case load. For Mystic, the configuration in which all units are at 100% of full load produced highest impacts for all meteorological conditions.

TABLE C-3

INPUTS USED IN PTMTPA MODELING FOR MYSTIC AND NEW BOSTON

Meteorological Conditions

Surface Wind Speed	Stability Class
2.5	A
2.5	C*
5.0	C
7.0	C
5.0	D
7.0	D
10.0	D
12.0	D
15.0	D

Receptor Distances (km)	Receptor Density
0.8 - 2.0	0.2 km spacing
2.5 - 9.0	0.5 km spacing
10 - 20	1.0 km spacing
22 - 40	2.0 km spacing
45 - 50	5.0 km spacing

---

*Mixing height set to 1 m above plume height to simulate plume trapping conditions.

New Boston Station

EPA's PTPLU and ISC models were employed in the worst-case assessment to determine highest plant impacts without and with the effects of building downwash, respectively. Each model calculated plant related impacts for each of the three New Boston configurations listed in Table C-2. PTPLU was employed as in the Mystic worst-case load assessment, i.e., the same options were included. The ISC model was then used in a worst-case mode while inputting the same range of meteorological conditions used in the Mystic PTMTPA modeling and the same building dimensions used in the sequential modeling (see Table 3-3). For both PTPLU and ISC, plant impacts were tabulated for each meteorological condition and for each emission configuration tested. Since the same configuration did not produce the highest impacts for each meteorological condition, the worst-case load was chosen based on that which produces highest impacts for a majority of the meteorological conditions tested. The worst-case load for New Boston was judged to be 100% of full load for both Units 1 and 2.

Further worst-case ISC modeling was performed to calculate maximum 1-hour average impacts from the interaction of Mystic Station at 100% of full load with New Boston at each of three emission configurations tested previously. This modeling was performed to test which New Boston emission configuration produces highest impacts when aligned with Mystic at its worst-case load. Wind directions were chosen such that the plume centerlines from both stations were aligned. Receptors were selected based on previous PTPLU, PTMTPA and ISC worst-case modeling for each station. The same range of meteorological conditions listed in Table C-3 was input to the model.

Results

Mystic Station

PTPLU was employed to estimate the maximum distance of highest impacts from each stack at the Mystic Station. Modeling was performed assuming all units are at 100% of full load. Results are presented in Table C-4 for the identical range of meteorological conditions used in later PTMTPA modeling. Highest concentrations for both stacks occur at similar distances downwind. This is expected because both stacks are 500' tall and have similar stack gas exit properties which produce similar plume rise. Highest 1-hour average plant impacts occur within 1 km for extremely unstable conditions (P-G stability Class A). Under slightly unstable conditions, (Class C) maximum impacts occur at distances of 4.3 to 9.6 km from the plant depending upon wind speed. Under neutral stabilities the distances to maximum impacts vary from 10.6 km to 27.5 km, again depending on wind speed.

Having selected appropriate receptor distances from the PTPLU modeling results, PTMTPA modeling was performed for the Mystic Station to determine worst-case load for all units at the station. Results are presented in Table C-5. As the table shows, highest concentrations are predicted to occur when all units are at 100% of full load. Therefore, this load was chosen for input to ISC in the sequential modeling.

New Boston

PTPLU was employed to estimate the maximum impact from New Boston without considering the effects of building downwash. Results are presented in Table C-6 for the three emission configurations mentioned previously. Maximum impacts occur either in association with configuration I (all units at 100% of full load) or II (Unit 1 at 100% load and Unit 2 at minimum load).

For the range of meteorological conditions presented, configuration I produces highest impacts in six out of the nine conditions. In general, both configurations produce impacts that are within 5-10% of each other, except in the case of stability Class A. For the latter stability, configuration I produces impacts which are a factor of 1.77 higher than those produced in configuration II.

The ISC model was then employed to estimate highest plant impacts from New Boston taking into account the enhanced dispersion due to building downwash effects. Results are presented in Table C-7. Configurations I and II produce highest impacts in seven out of the

TABLE C-4

PTPLU MODELING RESULTS FOR MYSTIC STATION - ALL UNITS AT 100% LOAD

Meteorology		Concentration ($\mu g/m^3$)/Distance (km)	
Stability	Surface Wind Speed (m/s)	Mystic 4, 5, 6	Mystic 7
A	2.5	633/0.93	708/0.95
C	2.5	114/9.0	121/9.6
C	5.0	148/5.3	159/5.6
C	7.0	155/4.3	169/4.5
D	5.0	45/25.5	47/27.5
D	7.0	51/18.4	55/19.6
D	10.0	54/13.8	59/14.5
D	12.0	54/12.1	60/12.8
D	15.0	53/10.6	59/11.0

TABLE C-5

RESULTS OF PTMTPA RUN FOR BOSTON EDISON'S MYSTIC STATION

Highest one hour SO_2 concentration ($\mu g/m^3$) and the downwind distance (km) of its occurrence for various meteorological conditions.

Met Condition		Case I		Case II	
Wind Speed (m/s)	Stability Class	Concentration	Downwind Distance From the Source	Concentration	Downwind Distance From the Source
2.5	A	1292	1.0	1149	1.0
2.5	C*	416	10.0	358	9.0
5.0	C	311	5.0	288	5.0
7.0	C	323	4.0	296	4.0
5.0	D	96	24.0	91	22.0
7.0	D	108	18.0	100	16.0
10.0	D	114	13.0	103	12.0
12.0	D	113	12.0	102	11.0
15.0	D	109	10.0	98	10.0

Met Condition		Case III		Case IV	
Wind Speed (m/s)	Stability Class	Concentration	Downwind Distance From the Source	Concentration	Downwind Distance From the Source
2.5	A	964	1.0	872	1.0
2.5	C*	299	9.0	270	9.0
5.0	C	243	5.0	214	5.0
7.0	C	249	4.0	221	4.0
5.0	D	78	20.0	69	20.0
7.0	D	86	16.0	76	16.0
10.0	D	87	12.0	78	12.0
12.0	D	86	11.0	76	11.0
15.0	D	82	10.0	73	10.0

Note

Case I: Units 4, 5, 6, 7 at 100% load
Case II: Units 4, 5 at 100% load, Unit 6 off & Unit 7 at 100% load
Case III: Units 5, 6 off line, Units 4 & 7 at 100% load
Case IV: Unit 6 at 50% load, 4 & 5 off line, Unit 7 at 100% load

*Plume trapping condition

TABLE C-6

PTPLU MODELING RESULTS FOR NEW BOSTON STATION

Stab	Wind Speed (m/sec)	Maximum Concentration ($\mu g/m^3$)/Distance (km) Case I	Case II	Case III
A	2.5	928/0.83	525/1.1	394/0.9
C*	2.5	293/9.9	302/8.1	284/5.0
C	5.0	215/5.4	210/4.6	167/3.1
C	7.0	242/4.2	229/3.6	166/2.6
D	5.0	66/26	70/20	65/11
D	7.0	83/18	84/14	69/9
D	10.0	99/12	94/10	67/7
D	12.0	104/10	97/9	65/6
D	15.0	108/9	97/8	60/6

Note:

Case I: Units 1 & 2 at 100% load/both on coal
Case II: Units 1 at 100%/Unit 2 at min load/both on coal
Case III: Unit 1 at 50%/Unit 2 off/both on coal

*Plume trapping condition.

TABLE C-7

ISC MODELING RESULTS FOR NEW BOSTON STATION

(Includes Building Downwash)

Meteorology		1-Hour Concentration ($\mu g/m^3$)/Distance (km)		
Wind Speed (m/s)	Stability	Case I	Case II	Case III
2.5	A	857/1.0	713/1.0	465/0.8
2.5	C*	263/1.0	254/9.0	225/6.0
5.0	C	203/6.0	201/4.5	161/3.0
7.0	C	231/4.5	220/3.5	162/2.5
5.0	D	62/27	66/20	62/11
7.0	D	79/18	80/14	131/0.6
10.0	D	94/12	91/10	189/0.6
12.0	D	100/10	299/0.6	204/0.6
15.0	D	386/0.6	349/0.6	209/0.6

Note:

Case I: Both units @ 100% load - Both units on coal
Case II: Unit 1 at 100%/Unit 2 @ main load - both units on coal
Case III: Unit 1 at 50%/Unit 2 off

*Plume trapping condition.

nine meteorological conditions presented. Configuration I produces highest impacts in five out of the nine cases. Configuration III produces highest impacts under neutral stability and 7.0 to 10.0 m/sec wind speeds. These high impacts occur close in to the plant and are associated with building downwash effects. Higher wind speeds (12.0 to 15.0 m/sec) cause the plumes from configurations I and II to become caught in the building wake also, resulting in high close-in impacts.

Results presented in Tables C-6 and C-7 indicate that configuration I at New Boston is the choice for worst-case load since it produces highest impacts in a majority of the meteorological conditions presented. Modeling of Mystic and New Boston plume interactions was then performed for the three New Boston emission configurations in order to finalize the choice of worst-case configuration at New Boston. Results are presented in Table C-8 for the case in which a northwest wind causes plume interaction to the southeast of New Boston (Case A) and a southeast wind causes plume interaction to the northwest of Mystic (Case B).

Highest impacts southeast of New Boston occur for a majority of the meteorological conditions in association with configuration II. However, configuration I impacts are within a few percent of those for configuration II. Highest impacts northwest of Mystic occur in association with configuration I and, in large part, are due to Mystic impacts at 100% load.

Results in Table C-8 indicate that either configuration I or II could be chosen as worst-case for New Boston. However, with the weight of previous modeling results (Tables C-6, C-7) in favor of Configuration I at New Boston, the latter was chosen as worst-case load for later input to the sequential ISC modeling runs.

TABLE C-8

RESULTS OF ISC WORST-CASE MODELING FOR MYSTIC AND NEW BOSTON SOURCE INTERACTION

A. Direct impact to the South of New Boston Station & Mystic (Distances of impacts are from New Boston)

Meteorology		Case I		Case II		Case III	
Wind speed (m/s)	Stab	Conc. (μg/m³)	Dist (km)	Conc. (μg/m³)	Dist (km)	Conc. (μg/m³)	Dist (km)
2.5	A	901	1.0	757	1.0	510	0.8
2.5	C*	433	3.5	572	8.0	559	4.5
5.0	C	369	5.0	381	4.0	374	3.0
7.0	C	379	4.0	380	3.5	346	2.5
5.0	D	149	25.0	155	20.0	143	15.0
7.0	D	178	17.5	182	14.0	175	7.0
10.0	D	200	11.0	200	10.0	247	0.6
12.0	D	206	10.0	371	0.6	277	0.6
15.0	D	472	0.6	435	0.6	295	0.6

B. Direct impact to the North of Mystic and New Boston Stations (Distances of Impacts are from New Boston)

Meteorology		Case I		Case II		Case III	
Wind Speed (m/s)	Stab.	Conc. (μg/m³)	Dist (km)	Conc. (μg/m³)	Dist (km)	Conc. (μg/m³)	Dist (km)
2.5	A	1298	7.4	1289	7.4	1277	7.4
2.5	C*	433	16.0	598	16.0	499	16.0
5.0	C	405	12.0	380	12.0	333	12.0
7.0	C	410	11.0	386	11.0	345	11.0
5.0	D	149	32.5	146	27.5	123	27.5
7.0	D	175	25.0	169	22.5	138	22.5
10.0	D	192	19.0	179	19.0	144	19.0
12.0	D	194	17.0	180	17.0	143	18.0
15.0	D	192	16.0	174	16.0	138	16.0

Note

Case I: All units at Mystic/New Bos @ 100% load
Case II: Mystic 4, 5, 6, 7 at 100% load/New Boston 1 at 100% & 2 at min load
Case III: Mystic 4, 5, 6, 7 at 100% load/New Boston 1 at 50% & 2 off

Tambient = 283°K, wind profile exponent considered
Urban mode 1 option used in ISC

APPENDIX D

MAJOR POINT SOURCE INVENTORY

APPENDIX D

MAJOR POINT SOURCE INVENTORY

A validated major point source emission inventory was required for use in this study's modeling. Table D-1 contains the inventory. The inventory was assembled in the following manner. The Massachusetts DEQE provided ERT with a list of all Boston area point sources having annual average SO_2 emissions of at least 100 tons per year. The list contains SO_2 emission rates for each source based on actual conditions. The latter means that the annual average fuel usage was divided by the actual operating hours for that year to obtain an average hourly fuel use from which an SO_2 emission rate was calculated. Stack locations (in terms of Universal Transverse Mercator coordinates) and stack base elevations were not provided by DEQE. These were obtained from emission inventories assembled as part of previous ERT studies performed for Boston Edison, Eastman Gelatine and Cambridge Electric (ERT Documents P-A376, P-A695, P-A807, respectively).

Stack parameters from the DEQE inventory were then compared to these emission inventories. In cases where discrepancies existed and ERT possessed first hand knowledge of a particular source's operating loads, changes were made to the DEQE data base. These changes have been discussed with DEQE personnel. The revised emission inventory was sent to the DEQE for their review as part of the final modeling protocol document. The DEQE approved the emission inventory in August 1982 prior to the ISC modeling.

Table D-2 contains the DEQE and EPA Region I approved inventory of PSD sources. This inventory was compiled as part of the three previously mentioned studies and from discussions with DEQE personnel.

TABLE D-1

EMISSION PARAMETERS ASSOCIATED WITH ACTUAL CONDITIONS FOR MAJOR SOURCES OF SULFUR DIOXIDE IN THE BOSTON AREA

Source	Unit	UTM Coordinates X (km)	UTM Coordinates Y (km)	Base Elevation (m)	Stack Height (m)	Stack Diameter (m)	Temperature (°K)	Exit Velocity (m/sec)	SO_2 Emission Rate (g/sec)	Distance (km) from Mystic	Distance (km) from New Boston	Qualifies As A Major Source To Be Modeled Sequentically
Revere Sugar	1	330.1	4694.1	6.1	54.9	2.9	396	2.6	4.7	1.08	5.39	Yes
	2				54.9	2.9	396	1.4	2.3			
	3				50.3	3.1	434	2.4	5.6			
	4				50.3	3.1	434	2.3	5.0			
Eastman Gelatine	1,2,3	340.7	4709.3	12.2	38.1	2.1	453	12.9	57.9[1]	17.96	21.77	Yes
	4				30.5	1.5	500	9.8	5.4			
	5				30.5	1.5	500	9.8	7.8			
General Dynamics	1	337.2	4678.5	3.0	61.0	2.6	510	8.3	22.3	18.22	11.83	No (<1000TPY)
General Electric (Lynn)	1	337.9	4701.5	3.0	38.1	2.3	461	14.6	29.2	10.40	13.49	Yes
	2				46.6	1.8	438	10.7	24.2			
	3				46.6	2.4	453	14.3	12.4			
	4				36.6	2.4	505	36.6	10.0			
Exxon	1	330.2	4696.0	3.0	9.1	0.9	561	19.8	2.0	1.03	7.13	Yes
	2				15.1	0.8	450	9.4	3.2			
Gillette	1	329.2	4688.4	6.1	48.8	1.8	421	15.2	6.9	6.72	3.25	Yes
Cambridge Electric (Kendall Sq.)	1 and 2	328.7	4691.9	5.5	53.4	3.1	427	14.1	10.4	3.35	4.54	Yes
	3				53.4	2.7	433	13.2	5.1			
	4 or 5				53.4	1.7	614	14.5	9.7			
Cambridge Electric (Blackstone St.)	5 or 6	325.8	4692.15	6.7	45.7	3.6	469	4.84	22.6[5]	4.89	7.18	Yes
	11 and 12				48.8	3.0	436	12.4	58.6[5]			
Polaroid	1	313.6	4696.0	39.6	45.7	1.2	561	42.7	4.5	16.13	19.94	No (<1000TPY)
International Airport	1	333.6	4692.4	3.0	17.4	1.5	439	15.1	2.2[4]	4.74	3.44	Yes
	2				17.1	2.1	437	6.9	2.2[4]			
Atlantic Gelatine	1	326.0	4704.7	18.3	45.7	1.8	436	4.9	3.7	10.29	16.75	No (<1000TPY)
	2				45.7	1.3	533	17.8	7.8			
	3				45.7	1.3	489	21.4	7.1			
Hanscom Field	1	313.2	4702.9	53.4	45.7	4.0	505	1.9	39.1	18.25	23.55	Yes
General Tire	1	326.7	4707.7	45.7	34.1	2.0	478	3.5	3.3	12.95	19.34	No (<1000TPY)
Matep	1	326.3	4789.1	3.0	96.0	3.45	422	24.46	90.14	6.94	6.0	Yes

TABLE D-1 (Continued)

Source	Unit	UTM Coordinates		Base Elevation (m)	Stack Height (m)	Stack Diameter (m)	Temperature (°K)	Exit Velocity (m/sec)	SO_2 Emission Rate (g/sec)	Distance (km) from		Qualifies As A Major Source To Be Modeled Sequentially
		X (km)	Y (km)							Mystic	New Boston	
Brandeis	1	314.0	4692.7	61.0	61.0	2.4	450	11.3	8.3	15.88	18.68	No (<1000TPY)
Boston Edison	1/2	330.5	4690.5	5.0	76.2	3.5	414	11.3	43.8[3]	4.67	2.26	Yes
Kneeland	3/4				76.2	4.0	436	10.5	59.3[3]			
MIT	1	327.6	4691.8	3.0	52.7	1.8	477	15.2	5.0	3.91	5.42	Yes
NEPCO	1	345.81	4709.65	6.4	76.2	3.20	392	14.2	212.95	21.74	24.51	Yes
(Salem Harbor	2	345.82	4709.67	6.4	76.2	3.14	385.5	13.1	198.88			
	3	345.83	4709.69	6.4	76.2	3.96	406.0	17.0	384.19			
	4	345.83	4709.72	4.9	130.7[2]	5.64	425.8	25.74	997.50			
Boston Edison (Mystic 7)	7	329.74	4695.18	3.0	152.4	5.80	463.7	27.5	1674.0			Yes-PSD Source
Diamond International	1	324.7	4680.5	15.2	46.9	2.44	408.0	2.75	11.21			Yes-PSD Source
Proctor & Gamble	1	337.8	4679.0	3.0	51.8[6]	1.82	465.0	7.30	24.8			Yes-PSD Source

---

[1] Represents use of 2.2% sulfur fuel oil and maximum load on units 1 and 3 and 50% load on boiler 2.
[2] Actual height is 152m. The lower height is GEP height (minus 4.9m) used in the modeling.
[3] Represents use of 0.5% sulfur fuel oil and actual maximum load conditions.
[4] Emissions data obtained from Logan International Airport.
[5] Represents use of 1.0% sulfur fuel oil and 100% load conditions.
[6] GEP stack height.

TABLE D-2

EMISSION INVENTORY FOR PSD INCREMENT CONSUMING SOURCES

Source	SO_2 Emission Rate (g/sec)	UTM Coordinates X (km)	UTM Coordinates Y (km)	Base Elevation (m)	Stack Height (m)	Stack Temperature (°K)	Exit Velocity (m/s)	Stack Diameter (m)
Boston Edison (Mystic 7)	913.09	329.74	4695.18	3.0	152.4	463.7	27.50	5.80
Diamond International	5.75	324.70	4680.50	15.2	46.9	408.0	2.75	2.44
Eastman Gelatine 1,2,3	26.57	340.70	4709.30	12.2	38.1	453.0	12.90	2.10
Proctor & Gamble	13.5	337.80	4679.00	3.0	51.8*	465.0	7.30	1.82
Cambridge Electric Blackstone Station								
Boiler 5 or 6	11.3	325.80	4692.15	6.7	45.7	469.0	4.84	3.60
Boiler 11 and 12	29.3	325.80	4692.15	6.7	48.8	436.0	12.40	3.0
Natick Paperboard[+]	+18.3	305.90	4684.40	45.7	45.7	416.00	4.92	1.52
	-8.5	305.90	4684.40	45.7	45.7	519.00	6.22	1.52

---

*GEP stack height.

[+] Modeled only at receptors located in Natick, i.e., this source was not included in the 5-year, 497 receptor modeling.

APPENDIX E

COORDINATES OF RECEPTOR LOCATIONS

APPENDIX E

COORDINATES OF RECEPTOR LOCATIONS

A total of 497 receptors were included in the ISC modeling. Since ISC has a limit of 400, two modeling runs were made for each source or group of sources for the NAAQS analysis. Since the PSD baseline date has been triggered only in a few cities and towns in the Boston area, PSD increment consumption was only calculated in these triggered areas. Therefore, the 497 receptor NAAQS grid was divided into two grids: a PSD increment consumption grid of 166 receptors and a non PSD increment consumption grid of 331 receptors. Consumption of SO_2 PSD increment was assessed on the PSD grid of 166 receptors. Compliance with the NAAQS was assessed on both grids.

Tables E-1 and E-2 contain the receptor locations for both grids expressed in Universal Transverse Mercator (UTM) coordinates. Table E-1 contains receptors located in the cities and towns where PSD increment consumption was assessed, i.e., Boston, Milton, Natick, Wellesley, Lawrence, N. Andover and Methuen. Table E-2 contains receptors located in other cities and towns in the greater Boston area. When referring to Tables E-1 and E-2 to determine receptor locations listed in the results section of this report, note that receptors located in the primary PSD baseline area are included in Table E-1.

TABLE E-1

RECEPTORS LOCATED IN PSD INCREMENT CONSUMING AREAS

1	325.5000	4675.5000	630.0000
2	327.0000	4676.0000	500.0000
3	328.0000	4678.0000	140.0000
4	325.0000	4678.0000	150.0000
5	324.0000	4679.5000	130.0000
6	326.0000	4679.5000	250.0000
7	329.0000	4679.0000	180.0000
8	330.0000	4679.0000	160.0000
9	328.0000	4680.0000	120.0000
10	330.0000	4681.0000	130.0000
11	327.5000	4681.5000	100.0000
12	322.0000	4682.0000	270.0000
13	324.5000	4682.0000	272.0000
14	326.0000	4682.0000	170.0000
15	323.0000	4682.0000	330.0000
16	327.0000	4683.0000	180.0000
17	330.0000	4683.5000	100.0000
18	329.0000	4683.5000	110.0000
19	320.0000	4684.0000	110.0000
20	322.0000	4684.0000	211.0000
21	323.0000	4684.0000	270.0000
22	326.0000	4684.5000	150.0000
23	332.0000	4684.0000	20.0000
24	330.0000	4685.5000	130.0000
25	324.0000	4686.0000	310.0000
26	326.0000	4686.5000	130.0000
27	328.0000	4686.0000	180.0000
28	330.0000	4686.5000	120.0000
29	332.0000	4686.0000	10.0000
30	334.0000	4686.0000	30.0000
31	333.0000	4686.0000	.0000
32	330.5480	4685.5920	27.0000
33	336.0000	4686.0000	56.0000
34	339.0000	4686.0000	55.0000
35	332.0000	4687.0000	10.0000
36	334.5000	4687.0000	70.0000
37	336.0000	4687.0000	60.0000
38	338.0000	4687.0000	100.0000
39	340.0000	4687.5000	60.0000
40	341.0000	4687.0000	40.0000
41	335.5000	4687.5000	.0000
42	331.0000	4687.0000	30.0000
43	333.0000	4687.0000	.0000
44	328.0000	4687.0000	160.0000
45	344.0000	4687.0000	.0000
46	343.0000	4687.0000	.0000
47	326.5000	4688.5000	220.0000
48	327.5000	4688.0000	160.0000
49	330.0000	4688.0000	10.0000
50	331.5000	4688.5000	130.0000
51	332.0000	4688.0000	70.0000
52	334.0000	4688.0000	.0000
53	336.0000	4688.0000	77.0000
54	339.0000	4688.0000	100.0000
55	341.0000	4688.0000	45.0000
56	342.0000	4688.0000	.0000
57	344.0000	4688.5000	103.0000
58	350.0000	4688.0000	.0000
59	329.5000	4688.5000	30.0000
60	334.0000	4688.5000	.0000
61	336.0000	4688.5000	.0000
62	337.0000	4688.0000	.0000
63	338.5000	4688.5000	.0000

TABLE E-1 (Continued)

64	333.0000	4688.0000	.0000
65	322.0000	4689.4000	160.0000
66	326.0000	4689.4000	30.0000
67	328.0000	4689.4000	20.0000
68	330.0000	4689.4000	20.0000
69	331.0000	4689.4000	20.0000
70	332.0000	4689.4000	10.0000
71	333.0000	4689.0000	60.0000
72	334.0000	4689.4000	10.0000
73	335.0000	4689.4000	30.0000
74	337.0000	4689.4000	.0000
75	340.0000	4689.4000	.0000
76	342.0000	4689.4000	.0000
77	346.0000	4689.4000	60.0000
78	352.0000	4689.4000	.0000
79	327.0000	4689.0000	100.0000
80	329.5000	4689.0000	30.0000
81	322.0000	4690.0000	170.0000
82	324.0000	4690.0000	260.0000
83	328.0000	4690.0000	20.0000
84	330.0000	4690.0000	15.0000
85	331.0000	4690.5000	10.0000
86	332.0000	4690.0000	10.0000
87	333.0000	4690.5000	.0000
88	334.0000	4690.0000	.0000
89	336.0000	4690.0000	.0000
90	338.5000	4690.5000	110.0000
91	344.0000	4690.0000	44.0000
92	350.0000	4690.0000	.0000
93	327.0000	4690.0000	20.0000
94	329.5000	4690.0000	30.0000
95	331.0000	4690.0000	20.0000
96	327.1000	4690.4000	20.0000
97	330.0000	4690.0000	25.0000
98	330.7620	4690.7850	27.0000
99	322.0000	4691.0000	160.0000
100	328.0000	4691.0000	.0000
101	330.0000	4691.5000	100.0000
102	332.0000	4691.0000	.0000
103	333.0000	4691.0000	.0000
104	334.0000	4691.0000	10.0000
105	335.0000	4691.0000	.0000
106	337.0000	4691.0000	.0000
107	340.0000	4691.0000	.0000
108	342.0000	4691.0000	.0000
109	346.0000	4691.0000	.0000
110	329.5000	4691.0000	20.0000
111	330.0000	4691.0000	30.0000
112	331.0000	4691.0000	20.0000
113	324.0000	4691.0000	110.0000
114	330.0000	4692.0000	30.0000
115	331.0000	4692.0000	50.0000
116	332.0000	4692.0000	60.0000
117	334.0000	4692.0000	10.0000
118	329.5000	4692.0000	20.0000
119	329.8280	4692.6510	25.0000
120	340.0000	4692.0000	.0000
121	342.0000	4692.0000	.0000
122	344.0000	4692.0000	.0000
123	346.0000	4692.0000	.0000
124	350.0000	4692.0000	.0000
125	352.0000	4692.0000	.0000
126	330.0000	4693.0000	80.0000

TABLE E-1 (Continued)

127	331.0000	4693.0000	10.0000
128	332.0000	4693.0000	50.0000
129	333.0000	4693.0000	10.0000
130	334.0000	4693.0000	10.0000
131	333.0000	4693.5500	20.0000
132	329.0000	4694.0000	50.0000
133	330.0000	4694.0000	100.0000
134	331.0000	4694.0000	10.0000
135	331.0000	4694.5000	110.0000
136	332.0000	4694.0000	80.0000
137	332.0000	4694.5000	50.0000
138	333.0000	4694.0000	60.0000
139	334.0000	4694.0000	60.0000
140	335.0000	4694.0000	20.0000
141	334.5000	4694.5000	160.0000
142	334.0000	4695.0000	80.0000
143	335.0000	4695.0000	70.0000
144	312.0000	4684.0000	260.0000
145	312.0000	4688.0000	270.0000
146	313.0000	4687.0000	320.0000
147	332.3000	4689.8000	10.0000
148	332.5300	4689.7500	10.0000
149	332.7200	4689.6300	.0000
150	332.8500	4689.4300	10.0000
151	332.9000	4689.2000	10.0000
152	332.6500	4688.9700	20.0000
153	332.7200	4688.7800	50.0000
154	332.5300	4688.6500	30.0000
155	332.3000	4688.6000	40.0000
156	332.0700	4688.6500	40.0000
157	331.8700	4688.7800	50.0000
158	331.7500	4688.9700	40.0000
159	331.7000	4689.2000	10.0000
160	331.7500	4689.4300	10.0000
161	331.8700	4689.6300	10.0000
162	332.0700	4689.7500	10.0000
163	330.0000	4719.0000	230.0000
164	320.0000	4730.0000	130.0000
165	325.0000	4727.0000	130.0000
166	306.6500	4684.6700	287.0000

TABLE E-2

RECEPTORS LOCATED OUTSIDE OF PSD INCREMENT CONSUMING AREAS

1	310.0000	4692.0000	260.0000
2	310.0000	4695.1000	150.0000
3	311.0000	4700.0000	380.0000
4	312.0000	4692.0000	250.0000
5	312.0000	4695.0000	334.0000
6	312.5000	4690.5000	356.0000
7	315.0000	4701.0000	354.0000
8	314.0000	4695.1000	478.0000
9	314.5000	4699.0000	345.0000
10	316.0000	4677.5000	350.0000
11	316.0000	4680.0000	250.0000
12	316.5000	4684.5000	262.0000
13	316.0000	4686.0000	150.0000
14	316.0000	4689.0000	220.0000
15	316.0000	4690.0000	150.0000
16	316.0000	4692.0000	110.0000
17	316.0000	4695.1000	170.0000
18	316.0000	4697.0000	330.0000
19	316.0000	4700.0000	280.0000
20	316.0000	4702.0000	350.0000
21	316.0000	4704.0000	280.0000
22	318.0000	4694.0000	70.0000
23	318.0000	4706.0000	150.0000
24	318.0000	4711.0000	180.0000
25	319.5000	4688.0000	290.0000
26	319.5000	4696.5000	302.0000
27	320.0000	4674.0000	50.0000
28	320.0000	4676.0000	150.0000
29	320.0000	4678.0000	100.0000
30	320.0000	4680.0000	140.0000
31	320.0000	4682.0000	120.0000
32	320.0000	4686.0000	302.0000
33	320.0000	4690.0000	210.0000
34	320.0000	4692.0000	40.0000
35	320.0000	4693.0000	180.0000
36	320.0000	4703.0000	250.0000
37	320.0000	4704.0000	280.0000
38	320.5000	4699.5000	320.0000
39	320.5000	4701.0000	374.0000
40	321.0000	4694.0000	230.0000
41	322.0000	4680.0000	130.0000
42	322.0000	4686.0000	310.0000
43	322.0000	4687.0000	220.0000
44	322.0000	4688.0000	280.0000
45	322.0000	4692.0000	40.0000
46	322.0000	4694.0000	140.0000
47	322.0000	4695.1000	110.0000
48	322.0000	4696.0000	20.0000
49	322.0000	4697.0000	110.0000
50	322.0000	4699.0000	240.0000
51	322.0000	4700.0000	310.0000
52	322.0000	4701.0000	350.0000
53	322.5000	4703.0000	287.0000
54	322.0000	4708.0000	170.0000
55	322.0000	4713.0000	100.0000
56	324.0000	4674.0000	160.0000
57	323.5000	4688.5000	270.0000
58	324.0000	4689.0000	240.0000
59	323.5000	4693.0000	136.0000
60	324.0000	4694.0000	70.0000
61	324.0000	4695.1000	50.0000
62	324.0000	4696.0000	20.0000
63	325.0000	4697.0000	140.0000

TABLE E-2 (Page 2 of 6)

64	326.0000	4700.0000	50.0000
65	324.5000	4704.5000	276.0000
66	326.0000	4670.0000	200.0000
67	326.0000	4690.0000	30.0000
68	326.0000	4691.0000	10.0000
69	326.0000	4692.0000	20.0000
70	326.0000	4693.0000	50.0000
71	326.0000	4694.0000	40.0000
72	326.5000	4695.0000	130.0000
73	326.0000	4696.0000	70.0000
74	326.0000	4697.0000	80.0000
75	326.0000	4698.5000	120.0000
76	327.0000	4700.0000	240.0000
77	325.5000	4702.0000	288.0000
78	327.0000	4703.0000	280.0000
79	326.0000	4706.0000	170.0000
80	326.0000	4710.0000	200.0000
81	326.0000	4714.0000	120.0000
82	327.0000	4703.5000	311.0000
83	328.0000	4692.0000	10.0000
84	328.0000	4693.0000	20.0000
85	328.0000	4694.0000	100.0000
86	327.0000	4695.5000	130.0000
87	328.0000	4696.0000	60.0000
88	328.0000	4699.0000	110.0000
89	328.5000	4700.5000	280.0000
90	328.5000	4703.0000	250.0000
91	328.0000	4704.0000	258.0000
92	328.0000	4706.0000	220.0000
93	328.0000	4708.0000	229.0000
94	328.0000	4710.0000	100.0000
95	329.0000	4693.0000	30.0000
96	329.0000	4695.1000	10.0000
97	329.0000	4696.0000	10.0000
98	329.0000	4697.0000	10.0000
99	329.0000	4698.0000	20.0000
100	329.0000	4699.0000	110.0000
101	329.0000	4701.0000	200.0000
102	329.0000	4704.0000	250.0000
103	330.0000	4676.0000	500.0000
104	330.5000	4678.0000	240.0000
105	330.0000	4696.0000	10.0000
106	330.0000	4697.0000	20.0000
107	330.0000	4698.0000	50.0000
108	330.0000	4699.0000	20.0000
109	330.0000	4700.0000	220.0000
110	330.0000	4701.0000	210.0000
111	330.0000	4703.0000	100.0000
112	330.0000	4704.0000	250.0000
113	330.0000	4706.0000	230.0000
114	330.0000	4708.0000	130.0000
115	330.0000	4715.0000	130.0000
116	331.0000	4695.0000	110.0000
117	331.0000	4696.0000	10.0000
118	331.0000	4697.0000	130.0000
119	331.0000	4698.0000	110.0000
120	331.0000	4699.0000	40.0000
121	331.0000	4700.0000	170.0000
122	331.0000	4701.0000	250.0000
123	331.0000	4704.0000	140.0000
124	332.0000	4669.0000	230.0000
125	332.0000	4674.0000	160.0000
126	332.0000	4678.0000	220.0000

TABLE E-2 (Page 3 of 6)

127	332.5000	4660.0000	160.0000
128	332.0000	4682.0000	70.0000
129	332.0000	4695.0000	110.0000
130	332.0000	4696.0000	80.0000
131	332.0000	4697.0000	170.0000
132	332.0000	4698.0000	140.0000
133	332.0000	4699.0000	10.0000
134	332.0000	4700.0000	200.0000
135	332.0000	4701.0000	262.0000
136	332.0000	4703.0000	160.0000
137	332.0000	4704.0000	190.0000
138	332.0000	4706.0000	250.0000
139	332.0000	4708.0000	120.0000
140	333.0000	4712.5000	201.0000
141	333.0000	4695.0000	110.0000
142	333.0000	4695.5000	120.0000
143	333.0000	4696.0000	180.0000
144	333.0000	4696.5000	100.0000
145	332.5000	4697.0000	170.0000
146	333.5000	4697.0000	180.0000
147	333.0000	4698.0000	160.0000
148	333.0000	4700.0000	190.0000
149	333.0000	4702.0000	270.0000
150	334.0000	4675.0000	200.0000
151	334.0000	4678.0000	130.0000
152	334.0000	4680.0000	120.0000
153	334.0000	4682.0000	20.0000
154	334.0000	4684.0000	60.0000
155	334.0000	4696.0000	60.0000
156	334.0000	4697.0000	180.0000
157	334.0000	4698.0000	100.0000
158	334.0000	4699.0000	50.0000
159	334.0000	4700.0000	120.0000
160	334.0000	4702.0000	140.0000
161	334.0000	4703.0000	90.0000
162	334.0000	4704.0000	150.0000
163	334.0000	4706.0000	130.0000
164	334.0000	4708.0000	180.0000
165	334.0000	4712.0000	230.0000
166	334.0000	4715.0000	195.0000
167	335.0000	4693.0000	.0000
168	335.0000	4696.0000	10.0000
169	335.5000	4696.5000	120.0000
170	335.0000	4697.0000	70.0000
171	335.5000	4669.5000	250.0000
172	336.0000	4673.0000	180.0000
173	335.5000	4677.5000	200.0000
174	336.0000	4680.0000	15.0000
175	336.0000	4682.0000	.0000
176	336.0000	4684.0000	.0000
177	336.0000	4685.5000	100.0000
178	336.0000	4692.0000	.0000
179	336.5000	4695.5000	100.0000
180	336.0000	4696.0000	20.0000
181	336.0000	4698.0000	20.0000
182	336.0000	4699.0000	10.0000
183	336.0000	4700.0000	10.0000
184	336.0000	4702.0000	140.0000
185	336.0000	4704.0000	240.0000
186	336.0000	4706.0000	273.0000
187	336.0000	4708.0000	270.0000
188	337.0000	4693.0000	40.0000
189	337.0000	4694.0000	90.0000

TABLE E-2 (Page 4 of 6)

190	337.0000	4696.0000	50.0000
191	338.0000	4671.0000	190.0000
192	338.0000	4671.0000	150.0000
193	338.0000	4676.0000	120.0000
194	338.0000	4680.0000	30.0000
195	338.0000	4682.0000	.0000
196	338.0000	4684.0000	.0000
197	338.0000	4692.0000	102.0000
198	338.0000	4693.0000	30.0000
199	338.0000	4696.0000	.0000
200	338.0000	4697.0000	.0000
201	338.0000	4698.0000	.0000
202	338.0000	4699.0000	.0000
203	338.0000	4700.0000	10.0000
204	338.0000	4702.0000	10.0000
205	338.0000	4703.0000	30.0000
206	338.0000	4704.0000	220.0000
207	338.0000	4706.0000	180.0000
208	338.0000	4708.0000	270.0000
209	338.0000	4710.0000	232.0000
210	340.0000	4676.5000	160.0000
211	340.0000	4679.0000	150.0000
212	340.5000	4680.0000	70.0000
213	339.0000	4682.0000	100.0000
214	340.5000	4684.5000	123.0000
215	340.0000	4693.0000	.0000
216	340.0000	4694.0000	.0000
217	340.0000	4695.1000	.0000
218	340.0000	4696.0000	.0000
219	340.0000	4697.0000	.0000
220	341.0000	4698.0000	80.0000
221	341.0000	4699.0000	80.0000
222	340.0000	4701.0000	.0000
223	340.0000	4703.0000	170.0000
224	340.0000	4706.0000	190.0000
225	341.0000	4707.5000	219.0000
226	343.0000	4672.0000	150.0000
227	342.0000	4674.0000	120.0000
228	342.0000	4676.0000	80.0000
229	342.5000	4678.5000	150.0000
230	343.5000	4679.5000	140.0000
231	341.0000	4681.0000	70.0000
232	343.0000	4685.0000	120.0000
233	342.0000	4694.0000	.0000
234	342.0000	4695.1000	.0000
235	342.0000	4696.0000	.0000
236	342.0000	4697.0000	.0000
237	342.0000	4699.0000	80.0000
238	342.0000	4701.0000	.0000
239	342.0000	4703.0000	50.0000
240	342.0000	4706.0000	180.0000
241	342.0000	4710.0000	100.0000
242	343.5000	4682.5000	70.0000
243	343.5000	4684.5000	50.0000
244	344.0000	4678.0000	90.0000
245	344.5000	4685.5000	110.0000
246	344.0000	4695.1000	.0000
247	344.0000	4699.0000	70.0000
248	344.0000	4701.0000	.0000
249	344.0000	4704.0000	120.0000
250	346.0000	4674.0000	150.0000
251	345.0000	4680.5000	121.0000
252	345.0000	4682.0000	50.0000

TABLE E-2 (Page 5 of 6)

253	345.0000	4683.5000	104.0000
254	346.0000	4691.0000	.0000
255	346.0000	4695.1000	.0000
256	346.0000	4697.0000	.0000
257	346.0000	4699.0000	.0000
258	346.0000	4701.0000	.0000
259	346.0000	4706.0000	70.0000
260	348.0000	4676.0000	.0000
261	348.0000	4708.0000	80.0000
262	349.0000	4700.0000	.0000
263	350.0000	4660.0000	.0000
264	350.0000	4662.0000	.0000
265	350.0000	4664.0000	.0000
266	350.0000	4666.0000	.0000
267	350.0000	4695.1000	.0000
268	350.0000	4697.0000	.0000
269	352.0000	4686.0000	.0000
270	312.0000	4660.0000	180.0000
271	316.0000	4663.0000	190.0000
272	318.0000	4665.5000	200.0000
273	320.5000	4667.0000	270.0000
274	348.5000	4711.5000	.0000
275	351.0000	4713.5000	100.0000
276	353.5000	4716.0000	216.0000
277	321.0000	4711.0000	220.0000
278	324.0000	4706.0000	220.0000
279	325.0000	4703.5000	150.0000
280	326.0000	4701.5000	270.0000
281	335.0000	4685.0000	40.0000
282	336.5000	4683.0000	.0000
283	337.5000	4660.5000	40.0000
284	339.0000	4677.5000	70.0000
285	341.0000	4674.0000	160.0000
286	343.0000	4670.0000	180.0000
287	320.0000	4670.0000	90.0000
288	321.5000	4673.0000	120.0000
289	324.0000	4676.0000	207.0000
290	347.5000	4712.0000	50.0000
291	349.5000	4715.0000	160.0000
292	351.5000	4718.0000	120.0000
293	327.0000	4692.0000	20.0000
294	327.0000	4691.0000	10.0000
295	324.0000	4688.0000	270.0000
296	324.0000	4687.0000	280.0000
297	338.0000	4694.5000	60.0000
298	334.0000	4697.0000	.0000
299	339.0000	4699.0000	.0000
300	333.0000	4664.0000	40.0000
301	333.0000	4682.0000	20.0000
302	327.0000	4697.0000	10.0000
303	327.0000	4698.0000	20.0000
304	326.0000	4698.0000	120.0000
305	324.0000	4698.0000	30.0000
306	322.0000	4698.0000	210.0000
307	320.0000	4693.0000	370.0000
308	318.0000	4698.0000	250.0000
309	338.0000	4712.0000	196.0000
310	338.0000	4714.0000	150.0000
311	342.0000	4713.0000	80.0000
312	349.0000	4703.0000	.0000
313	341.0000	4683.5000	.0000
314	341.0000	4662.0000	.0000
315	348.0000	4665.0000	.0000

TABLE E-2 (Page 6 of 6)

316	348.0000	4663.0000	.0000
317	348.0000	4660.5000	100.0000
318	326.0000	4700.0000	220.0000
319	324.0000	4701.0000	110.0000
320	320.0000	4706.0000	250.0000
321	318.0000	4695.0000	240.0000
322	316.0000	4701.0000	270.0000
323	328.0000	4695.0000	70.0000
324	315.9000	4693.5000	75.0000
325	320.3100	4693.5000	60.0000
326	326.6000	4696.6000	50.0000
327	326.5000	4695.5500	35.0000
328	342.9000	4708.2000	75.0000
329	337.3000	4678.0000	10.0000
330	339.1710	4701.4630	10.0000
331	326.4620	4704.3850	10.0000

Document P-B318-500
May 1983

Prepared for
Boston Edison Company
Boston, Massachusetts 02199

An Evaluation of Sulfur Content Fuel for Use at Mystic and New Boston Stations

Supplemental Analyses

ENVIRONMENTAL RESEARCH & TECHNOLOGY, INC.
ATLANTA · CHICAGO · CONCORD, MA · FORT COLLINS, CO
HOUSTON · LOS ANGELES · PITTSBURGH · WASHINGTON, DC

1. INTRODUCTION

This report was prepared by Environmental Research & Technology, Inc. (ERT) for the Boston Edison Company. It is a supplement to ERT document P-B318-200, dated October 1982, which reported the results of a comprehensive sulfur dioxide (SO_2) air quality modeling study for the proposed conversion of the Mystic and New Boston Generating Stations to coal. The modeling reported in P-B318-200 was based on the stack data presented in Table 1-1. Mystic Units 4, 5, and 6 and New Boston Units 1 and 2 are proposed candidates for conversion to coal. Subsequent to publishing P-B318-200, a more refined engineering assessment indicated that the stack exhaust characteristics would be different from the data presented in Table 1-1. These refined engineering estimates of the stack exhaust characteristics for the candidate Mystic and New Boston Units are shown in Table 1-2. Please note that the stack data for Mystic Unit 7, which is oil-fired and not a proposed candidate for coal conversion, have not changed. In this report we present the results of new air quality modeling which account for the refined stack parameters presented in Table 1-2. This remodeling was performed in the same manner as the original modeling. That is, the modeling protocol presented in Section 3 of the P-B318-200 document was followed exactly except that the referenced stack parameters for the proposed coal-fired units were changed to the refined estimates presented in Table 1-2. All other input data referenced in the protocol remained unchanged.

TABLE 1-1

ORIGINAL BOSTON EDISON SO_2 EMISSION PARAMETERS FOR THE PROPOSED COAL FIRED CONFIGURATION AT NEW BOSTON AND MYSTIC STATIONS

Station	Fuel	Unit	Stack Height (m)	Stack Temperature (°K)	Exit Velocity (m/sec.)	Equivalent Diameter (m)	SO_2 (g/s)	Configuration
Mystic	1.5% S Coal	4, 5, 6	152.4	400.0	35.7	5.54	1421.0	4,5,6,7 at 100% load
Mystic	2.2% S Oil	7	152.4	463.7	27.5 (actual)	5.8	1674.0	
New Boston	1.5% S Coal	1, 2	113.4	400.0	35.4	6.08	2014.0	Units 1, 2, at 100% load

Note: Same as Table 3-3 in ERT Document PB 318-200

TABLE 1-2

REVISED BOSTON EDISON SO_2 EMISSION PARAMETERS FOR THE PROPOSED COAL FIRED CONFIGURATION AT NEW BOSTON AND MYSTIC STATIONS

Station	Fuel	Unit	Stack Height (m)	Stack Temperature (°K)	Exit Velocity (m/sec.)	Equivalent Diameter (m)	SO2 (g/s)	Configuration
Mystic	1.5% S Coal	4, 5, 6	152.4	408.0	28.5	5.36	1216.0	4,5,6,7 at 100% load
Mystic	2.2% S Oil	7	152.4	463.7	27.5 (actual)	5.8	1674.0	
New Boston	1.5% S Coal	1, 2	112.7	413.0	27.4	7.10	2174.0	Units 1, 2, at 100% load

2. SUMMARY AND CONCLUSION

Remodeling the coal-fired units with refined stack parameters did not change the conclusion of the original study. The proposed candidate units could be fired on coal with an average sulfur content of 1.5% without causing a violation of ambient SO_2 standards or PSD increments.

As with original results, further analysis of the new results also indicates that compliance with short-term 3-hour and 24-hour ambient standards could be achieved at sulfur contents considerably higher than 1.5%. For the Mystic candidate units, the new model results indicate that 4.7% sulfur content coal could be fired without causing a violation of short-term ambient standards. For the candidate New Boston units, compliance with short-term ambient standards is indicated up to coal sulfur contents of 4.3%. Thus, each station has a different complying coal sulfur content: 4.7% for the candidate Mystic units and 4.3% for the candidate New Boston units. This is somewhat different from the complying coal sulfur content presented in the original study. The results presented in the original study indicated that the complying coal sulfur content for both Mystic and New Boston, based on plume interaction between the two plants, was 4.6% . The new results indicate separate complying coal sulfur contents because plume interaction between the Mystic and New Boston stations is no longer the limiting case for the candidate New Boston units. The limiting case for the New Boston units results from the ambient impact of their SO_2 emissions without plume interaction with the Mystic Station. The Mystic complying sulfur content is still controlled by plume interaction between the two plants.

Conclusion

Remodeling with refined stack parameters indicates that Mystic Units 4, 5, and 6 and New Boston Units 1 and 2 could fire coal with a 30-day average sulfur content of 1.5% without causing a violation of ambient standards or PSD increments. Short-term ambient standards would be adequately protected if the coal sulfur content were not to exceed 4.7% at Mystic and 4.3% at New Boston. Since 4.7% and 4.3%

are the highest short-term coal sulfur content averages which ensure maintenance of both the primary 24-hour standard and the secondary 3-hour standard, each is referred to as a complying sulfur content. 4.7% coal sulfur content would be complying for Mystic and 4.3% coal sulfur content would be complying for New Boston.

3. REVISED MODELING RESULTS

Results of remodeling the candidate coal-fired units for refined stack exhaust characteristics are presented in this section. Significant changes from the original results presented in Sections 4 and 5 of ERT Document PB-318-200 are not indicated by the new results. The tables presented in Sections 4 and 5 of PB-318-200 were amended to reflect the new results and are presented in this section as revised tables. Thus, Table 4-1 in PB-318-200 was amended as required and presented herein as Table 4-1 (Revised). In addition we have provided two (2) additional tables, and these are designated Table 4-4A (New) and Table 4-5A (New). These new tables present the complying coal sulfur content for maintenance of the 3-hour standard and are included to provide the reader with additional information concerning the complying coal sulfur content assessment. Please note that in the original study plume interaction between the Mystic and New Boston units was found to limit the complying coal sulfur content to 4.6% for both stations.

Although the results presented in the revised tables and the two new tables do not indicate a significant departure from the original results, there are three points worthy of discussion:

1) The New Boston Complying Coal Sulfur content is still controlled by a 24-hour meteorological period but no longer constrained by a plume interaction with the Mystic Station. The most limiting case for the candidate New Boston units is now a 24-hour case that involves New Boston plume impact at ground level without a contribution from the Mystic units. This is clearly evident in Table 4-4 (Revised) for meteorological year 1978 where a 4.3% complying sulfur content was calculated for the New Boston units and the table entry for a Mystic contribution is 0. The most limiting interaction case with Mystic will result in a complying coal sulfur content of 4.7%; this is also shown in Table 4-4 (Revised) for meteorological year 1980.

2) The New Boston complying coal sulfur content based on 3-hour averages, shown in Table 4-5(A) (New), is 4.4%, which is almost identical to the limiting 24-hour complying coal sulfur content of 4.3%. Again, the 4.4% is derived from a 3-hour meteorological case which does not involve a plume interaction with the Mystic Station.

3) The complying coal sulfur content for the candidate Mystic units is 4.7%, and, as in the original modeling, this result is derived from a 24-hour meteorological period which causes the New Boston and Mystic plumes to interact. This is shown in Table 4-4 (Revised) for meteorological year 1980.

TABLE 4-1 (REVISED)

HIGHEST 24-HOUR AVERAGE SO_2 CONCENTRATIONS
PREDICTED IN THE PRIMARY PSD BASELINE AREA
(CANDIDATE UNITS AT 1.5% SULFUR CONTENT COAL)

Year	Day	Receptor Location	Concentration ($\mu g/m^3$)	Category
1977	054	Boston/Brookline Bndry (Rec #082)	162.5	Highest
	287	Boston/Brookline Bndry (Rec #082)	160.5	Highest-Second Highest
1978	037	Boston (Rec. #158)	198.0	Highest
	048	Boston Harbor (Rec. #037)	164.2	Highest-Second Highest
1979	050	Milton, Great Blue Hill (Rec #001)	195.8	Highest
	057	Boston, Hyde Park (Rec #005)	154.3	Highest-Second Highest
1980	015	Milton, Hancock Hill (Rec #002)	191.1	Highest
	016	Milton, Hancock Hill (Rec #002)	181.9*	Highest-Second Highest*
1981	015	Milton (Rec #008)	201.1	Highest
	016	Boston Harbor (Rec #076)	164.8	Highest-Second Highest

---

*Highest-second-highest concentration for the 5-year meteorological period for receptors within the primary PSD baseline area.

NOTE: 24-Hour NAAQS = 365 $\mu g/m^3$.

TABLE 4-2 (REVISED)

HIGHEST 24-HOUR AVERAGE SO_2 CONCENTRATIONS PREDICTED OUTSIDE THE PRIMARY PSD BASELINE AREA (CANDIDATE UNITS AT 1.5% SULFUR CONTENT COAL)

Year	Day	Receptor Location	Concentration ($\mu g/m^3$)	Category
1977	034	Beverly (Rec #275)	238.6	Highest
	069	Manchester (Rec #276)	230.2*	Highest-Second Highest
1978	195	Beverly (Rec #275)	235.7	Highest
	024	Beverly (Rec #275)	203.5	Highest-Second-Highest
1979	060	Salem/Peabody Bndry (Rec #225)	263.2	Highest
	346	Beverly (Rec #275)	202.3	Highest-Second Highest
1980	353	Manchester (Rec #276)	276.2	Highest
	050	Beverly (Rec #275)	185.5	Highest-Second Highest
1981	015	Salem/Peabody Bndry (Rec #225)	247.5	Highest
	054	Salem/Peabody Bndry (Rec #225)	229.4	Highest-Second Highest

---

*Highest-second-highest concentration for the 5-year meteorological period for receptors outside of the primary PSD baseline area.

NOTE: 24-Hour NAAQS = 365 $\mu g/m^3$.

TABLE 4-3 (REVISED)

TWENTY-FIVE HIGHEST 24-HOUR AVERAGE CONCENTRATION DAYS PREDICTED BY THE ISC MODEL

(CANDIDATE UNITS AT 1.5% SULFUR CONTENT COAL)

Year	Day	Receptor Location	Concentration ($\mu g/m^3$)
1980	353	Manchester (Rec #276)	276.2
1979	060	Salem/Peabody Bndry (Rec #225)	263.2
1981	015	Salem/Peabody Bndry (Rec #225)	247.5
1977	034	Beverly (Rec #275)	238.6
1979	052	Beverly (Rec #275)	236.3
1978	195	Beverly (Rec #275)	235.7
1977	069	Manchester (Rec #276)	230.2
1981	054	Salem/Peabody Bndry (Rec #225)	229.4
1977	024	Manchester (Rec #276)	215.6
1979	346	Manchester (Rec #276)	211.6
1979	050	Quincy (Rec #103)	210.6
1981	319	Brookline (Rec #295)	206.5
1978	135	Salem (Rec #240)	204.5
1978	024	Beverly (Rec #275)	203.5
1978	037	Boston (Rec. 158)	198.0
1978	013	Quincy (Rec #103)	199.3
1978	236	Salem/Peabody Bndry (Rec #225)	193.9
1978	349	Beverly (Rec #275)	193.2
1980	364	Mass. Bay (Rec #258)	191.8
1980	015	Milton (Rec #002 - Primary PSD Area)	191.1
1978	346	Manchester (Rec #276)	191.2
1981	016	Weymouth (Rec #192)	190.5
1978	299	Beverly (Rec #291)	189.8
1977	055	Peabody (Rec #209)	189.5
1977	040	Manchester (Rec #276)	187.9

NOTE: 24-Hour NAAQS = 365 $\mu g/m^3$.

TABLE 4-4 (REVISED)

COMPLYING SULFUR CONTENT LIMITATIONS FOR THE MYSTIC STATION

			24-Hour Average Source Contributions ($\mu g/m^3$)					
Year	Day	Receptor Location	Mystic	New Boston	Background	Total ($\mu g/m^3$)	Limiting Sulfur Content (%)	Category*
1977	287	Boston (Rec #015 Primary PSD Area)	4.8	94.0	43.1	141.9	4.9	Lowest
	155	Waltham (Rec #008)	39.4	10.6	92.8	142.8	> 5.0	Lowest-Second Lowest
1978	013	Quincy (Rec #103)	36.1	31.7	131.5	199.3	> 5.0	Lowest
	014	Quincy (Rec #103)	11.5	64.8	65.0	141.3	> 5.0	Lowest-Second Lowest
1979	117	Medford (Rec #089)	40.9	51.4	60.0	152.9	> 5.0	Lowest
	032	Boston Harbor(Rec #214)	12.9	45.5	67.0	125.4	> 5.0	Lowest-Second Lowest
1980	015	Hancock Hill, Milton (Rec #002 Primary PSD Area)	24.5	70.4	96.2	191.1	4.3	Lowest
	016	Hancock Hill, Milton (Rec #002 Primary PSD Area)	18.3	68.4	95.2	181.9	4.7**	Lowest-Second Lowest
1981	319	Great Blue Hill, Milton (Rec #001 Primary PSD Area)	1.2	69.4	66.1	136.7	> 5.0	Lowest
	056	Great Blue Hill, Milton (Rec #001 Primary PSD Area)	40.9	20.1	64.8	125.8	> 5.0	Lowest-Second Lowest

---

*Lowest is the lowest limiting sulfur content over all 497 receptors.
Lowest-second lowest is the lowest of all second lowest limiting sulfur contents calculated over all 497 receptors.

**Complying coal sulfur content for the Mystic Station.

NOTE: 24-Hour NAAQS = 365 $\mu g/m^3$.

TABLE 4-4A (NEW)

COMPLYING SULFUR CONTENT LIMITATIONS FOR THE MYSTIC STATION

Year	Day	3-Hours Ending	Receptor Location	3-Hour Average Source Contributions ($\mu g/m^3$) Mystic	New Boston	Background	Total ($\mu g/m^3$)	Limiting Sulfur Content (%)	Category*
1977	140	1200	Medford (Rec #088)	149.7	127.4	227.3	504.4	> 5.0	Lowest
	140	1200	Medford (Rec #076)	90.5	102.9	145.0	338.4	> 5.0	Lowest-Second Lowest
1978	275	1200	Boston Harbor (Rec #030 Primary PSD Area)	61.3	175.9	107.4	344.6	> 5.0	Lowest
	245	1200	Medford (Rec #303)	128.0	44.2	177.0	349.2	> 5.0	Lowest-Second Lowest
1979	117	0600	Stoneham (Rec #078)	110.6	151.2	137.6	399.4	> 5.0	Lowest
								> 10.0$^+$	Lowest-Second Lowest
1980	185	1200	Cambridge (Rec #061)	216.7	0.0	217.1	433.8	> 5.0	Lowest
	145	1200	Cambridge (Rec #061)	225.7	0.0	124.0	349.7	> 5.0	Lowest-Second Lowest
1981	233	1200	Medford (Rec #076)	232.3	91.9	213.2	537.4	> 5.0	Lowest
	041	1200	Medford (Rec #076)	121.4	77.0	222.3	420.7	> 5.0	Lowest-Second Lowest

---

*Lowest is the lowest limiting sulfur content over all 497 receptors.
Lowest-second lowest is the lowest of all second lowest limiting sulfur contents calculated over all 497 receptors.

+ The computer program was designed to print out source contributions only for complying sulfur contents ≤10%.

NOTE: 3-Hour NAAQS = 1300 $\mu g/m^3$.

TABLE 4-5 (REVISED)

COMPLYING SULFUR CONTENT LIMITATIONS FOR THE NEW BOSTON STATION

			24-Hour Average Source Contributions ($\mu g/m^3$)					
Year	Day	Receptor Location	Mystic	New Boston	Background	Total ($\mu g/m^3$)	Limiting Sulfur Content (%)	Category*
1977	287	Boston (Rec #050 Primary PSD Area)	0.0	127.0	29.5	156.5	4.0	Lowest
	263	Boston (Rec #015 Primary PSD Area)	0.3	69.7	37.9	107.9	> 5.0	Lowest-Second-Lowest
1978	037	Boston (Rec #158 Primary PSD Area)	0.0	146.5	51.5	198.0	3.2	Lowest
	020	Boston (Rec #158 Primary PSD Area)	0.0	112.6	44.6	157.2	4.3**	Lowest-Second Lowest
1979	117	Medford (Rec #089)	40.9	51.4	60.0	152.3	> 5.0	Lowest
	096	Boston (Rec #071 Primary PSD Area)	0.0	66.1	47.4	113.5	> 5.0	Lowest-Second-Lowest
1980	015	Hancock Hill, Milton (Rec #002 Primary PSD Area)	24.5	70.4	96.2	191.1	4.3	Lowest
	016	Hancock Hill, Milton (Rec #002 Primary PSD Area)	18.3	68.4	95.2	181.9	4.7	Lowest-Second-Lowest
1981	073	Boston (Rec #153 Primary PSD Area)	0.0	108.8	42.9	151.7	4.4	Lowest
	340	Boston (Rec #153 Primary PSD Area)	0.0	92.1	28.0	120.1	> 5.0	Lowest-Second-Lowest

---

*Lowest is the lowest limiting sulfur content over all 497 receptors.
Lowest-second lowest is the lowest of all second lowest limiting sulfur contents calculated over all 497 receptors.

**Complying coal sulfur content for the New Boston Station.

NOTE: 24-Hour NAAQS = 365 $\mu g/m^3$.

TABLE 4-5A (NEW)

COMPLYING SULFUR CONTENT LIMITATIONS FPR THE NEW BOSTON STATION

Year	Day	3-Hours Ending	Receptor Location	3-Hour Average Source Contributions ($\mu g/m^3$)			Total ($\mu g/m^3$)	Limiting Sulfur Content (%)	Category*
				Mystic	New Boston	Background			
1977	081	2400	Boston (Rec #158 Primary PSD Area)	0.0	379.1	11.9	391.0	> 5.0	Lowest
	339	2400	Boston (Rec #158 Primary PSD Area)	0.0	343.5	17.6	361.1	> 5.0	Lowest-Second Lowest
1978	038	0300	Boston (Rec #157 Primary PSD Area)	0.0	662.2	13.3	675.5	2.9	Lowest
	037	2400	Boston (Rec #157 Primary PSD Area)	0.0	443.8	12.9	456.7	4.4	Lowest-Second Lowest
1979	193	1500	Boston (Rec #047 Primary PSD Area)	0.0	364.4	31.9	396.3	> 5.0	Lowest
	056	1800	Boston (Rec #050 Primary PSD Area)	0.0	295.0	23.3	318.3	> 5.0	Lowest-Second Lowest
1980	145	1200	Brookline (Rec #058)	0.0	362.9	38.9	401.8	> 5.0	Lowest
	185	1200	Brookline (Rec #058)	0.0	297.1	45.0	342.1	> 5.0	Lowest-Second Lowest
1981	233	1200	Melford (Rec #076)	232.3	91.9	213.2	537.4	> 5.0	Lowest
	073	1800	Boston (Rec #153 Primary PSD Area)	0.0	295.3	33.6	328.9	> 5.0	Lowest-Second Lowest

---

*Lowest is the lowest limiting sulfur content over all 497 receptors.
Lowest-second lowest is the lowest of all second lowest limiting sulfur contents calculated over all 497 receptors.

NOTE: 3-Hour NAAQS = 1300 $\mu g/m^3$.

TABLE 4-6 (REVISED)

HIGHEST 24-HOUR AVERAGE SO_2 CONCENTRATIONS WITH MYSTIC AND NEW BOSTON AT COMPLYING SULFUR CONTENT COALS

NEW BOSTON @ 4.3%

MYSTIC @ 4.7%

			Source Contributions ($\mu g/m^3$)			Total	
Year	Day	Receptor Location	Mystic	New Boston	Background	($\mu g/m^3$)	Category*
1977	287	Boston (Rec #050 Primary PSD Area)	0.0	362.0	29.5	391.5**	Highest
	268	Boston (Rec #008)	122.4	30.2	92.8	245.4	Highest-Second-Highest
1978	037	Boston (Rec #158 Primary PSD Area)	0.0	417.6	51.5	469.1**	Highest
	020	Boston (Rec #158 Primary PSD Area)	0.0	320.4	44.6	365.0	Highest-Second-Highest
1979	117	Medford (Rec #089)	127.2	146.5	60.0	333.7	Highest
	050	Quincy (Rec #103)	55.7	50.8	174.9	281.4	Highest-Second-Highest
1980	015	Milton (Rec #002 Primary PSD Area)	76.2	200.7	96.2	373.1**	Highest
	016	Milton (Rec #002 Primary PSD Area)	56.9	195.0	95.2	347.1	Highest-Second-Highest
1981	073	Boston (Rec #153 Primary PSD Area)	0.0	310.0	42.9	352.9	Highest
	340	Boston (Rec #153 Primary PSD Area)	0.0	262.4	28.0	290.4	Highest-Second-Highest

---

*Highest is the highest predicted concentration over all 497 receptors.
Highest-second highest is the highest of all second highest concentrations calculated over all 497 receptors.

**One exceedance of the 24-hour NAAQS of 365 $\mu g/m^3$ is allowed at each receptor each year.

Note: 24-Hour NAAQS = 365 $\mu g/m^3$.

TABLE 4-7 (REVISED)

HIGHEST 3-HOUR AVERAGE SO_2 CONCENTRATIONS WITH MYSTIC AND NEW BOSTON AT COMPLYING SULFUR CONTENT COAL

NEW BOSTON @ 4.3%

MYSTIC @ 4.7%

Year	Day	3-Hours Ending	Receptor Location	Concentration ($\mu g/m^3$)	Category*
1977	081	2400	Boston (Rec #158 Primary PSD Area)	1092.4	Highest
	339	2400	Boston (Rec #158 Primary PSD Area)	996.6	Highest-Second-Highest
1978	038	0300	Boston (Rec #157 Primary PSD Area)	1900.4**	Highest
	037	2400	Boston (Rec #157 Primary PSD Area))	1277.7	Highest-Second-Highest
1979	193	1500	Boston (Rec #047 Primary PSD Area)	1070.3	Highest
	056	1800	Boston (Rec #050 Primary PSD Area)	864.1	Highest-Second-Highest
1980	145	1200	Brookline (Rec #058)	1073.2	Highest
	185	1200	Brookline (Rec #058)	891.7	Highest-Second-Highest
1981	233	1200	Medford (Rec #076)	1197.5	Highest
	340	1800	Medford (Rec #153 Primary PSD Area)	875.1	Highest-Second-Highest

---

*Highest is the highest predicted concentration over all 497 receptors.
Highest-second-highest is the highest of all second highest concentrations calculated over all 497 receptors.

**One exceedance of the 3-hour NAAQS of 1300 $\mu g/m^3$ is allowed at each receptor each year.

TABLE 4-8 (REVISED)

HIGHEST ANNUAL AVERAGE SO_2 CONCENTRATIONS PREDICTED IN THE PRIMARY PSD BASELINE AREA

		Source Contributions ($\mu g/m^3$)		
Year	Receptor Location	Modeled Sources	Monitored Background*	Total ($\mu g/m^3$)
1977	Boston (Rec #135)	14.9	38.0	52.9
1978	Boston Harbor (Rec #057)	14.0	40.0	54.0
1979	Boston (Rec #135)	13.0	35.9	48.9
1980	Boston Harbor (Rec #038)	14.1	35.2	49.3
1981	Boston Harbor (Rec #057)	14.3	33.9	48.2

---

*Represents a regional annual average background concentration as it is the average of all hourly monitored values for that particular year.

Note: Annual average NAAQS for SO_2 = 80 $\mu g/m^3$.

TABLE 4-9 (REVISED)

HIGHEST ANNUAL AVERAGE SO_2 CONCENTRATIONS PREDICTED OUTSIDE THE PRIMARY PSD BASELINE AREA

		Source Contributions ($\mu g/m^3$)		
Year	Receptor Location	Modeled Sources	Monitored Background*	Total ($\mu g/m^3$)
1977	Peabody (Rec #241)	23.7	38.0	61.7
1978	Marblehead (Rec #261)	21.5	40.0	61.5
1979	Marblehead (Rec #261)	21.5	35.9	57.4
1980	Marblehead (Rec #261)	23.5	35.2	58.7
1981	Marblehead (Rec #261)	20.9	33.9	54.8

---

*Represents a regional annual average background concentration as it is the average of all hourly monitored values for that particular year.

Note: Annual average NAAQS for SO_2 = $80\mu g/m^3$.

TABLE 5-1 (REVISED)

HIGHEST 3-HOUR AVERAGE SO_2 PSD INCREMENT CONSUMPTION IN PRIMARY PSD BASELINE AREAS FROM SOURCES MODELED IN THIS STUDY

Year	Day	Hour Ending	Location	Concentration (μg/m3)	Category
1977	136	1200	Boston (Rec #142)	154.3	Highest
	136	1200	Boston (Rec #141)	106.5	Highest Second Highest
1978	275	1200	Boston (Rec #102)	107.8	Highest
	174	1200	Boston (Rec #141)	90.3	Highest Second Highest
1979	167	1200	Boston (Rec #141)	146.7	Highest
	185	1200	Boston (Rec #143)	98.4	Highest Second Highest
1980	127	0900	Boston (Rec #113)	165.2	Highest
	015	1500	Milton, Blue Hill (Rec #001)	113.8	Highest Second Highest
1981	146	1200	Boston (Rec #141)	140.3	Highest
	320	0300	Boston (Rec #025)	101.4	Highest Second Highest

Note: PSD increment for a 3-hour average = 512 $\mu g/m^3$

TABLE 5-2 (REVISED)

HIGHEST 3-HOUR AVERAGE SO_2 PSD INCREMENT CONSUMPTION IN PERIMETER PSD BASELINE AREAS FROM SOURCES MODELED IN THIS STUDY

Year	Day	Hour Ending	Location	Concentration(μg/m^3)	Increment Already Consumed (μg/m^3)	Total(μg/m^3)
1977	269	1800	N. Andover	47.9	42.7	90.6
	193	1800	Methuen	36.6	35.0	71.6
	024	1500	Lawrence	27.8	115.0	142.8
	114	0600	Natick	45.7	199.7	245.4
1978	176	0900	N. Andover	41.6	42.7	84.3
	200	0900	Methuen	38.4	35.0	73.4
	168	0900	Lawrence	51.6	115.0	166.6
	145	0300	Natick	60.7	199.7	260.4
1979	112	0900	N. Andover	68.7*	42.7	111.4
	002	1800	Methuen	41.3*	35.0	76.3
	296	1800	Lawrence	41.7	115.0	156.7
	115	0900	Natick	66.1*	199.7	265.8
1980	190	1500	N. Andover	38.1	42.7	80.8
	101	1500	Methuen	28.6	35.0	63.6
	101	1800	Lawrence	57.3*	115.0	172.3
	210	1200	Natick	53.4	199.7	253.1
1981	032	2400	N. Andover	44.5	42.7	87.2
	050	1800	Methuen	26.1	35.0	61.1
	135	1500	Lawrence	44.8	115.0	159.8
	142	1500	Natick	64.9	199.7	264.6

Note: PSD increment for a 3-hour average = 512 μg/m^3.

*Highest 3-hour PSD increment consumption in this city/town for the 5-year modeling period.

TABLE 5-3 (REVISED)

HIGHEST 24-HOUR AVERAGE SO_2 PSD INCREMENT CONSUMPTION IN PRIMARY PSD BASELINE AREAS FROM SOURCES MODELED IN THIS STUDY

Year	Day	Location (UTM)	Concentration (μg/m3)	Cagetory*
1977	287	Boston (Rec #082)	35.2	Highest
	161	Boston (Rec #025)	31.0	Highest Second Highest
1978	014	Hancock Hill, Milton (Rec #002)	39.3	Highest
	326	Hancock Hill, Milton (Rec #002)	26.1	Highest Second Highest
1979	057	Boston (Rec #082)	31.7	Highest
	224	Boston (Rec #082)	31.6	Highest Second Highest
1980	015	Great Blue Hill, Milton (Rec #001)	44.4	Highest
	017	Hancock Hill, Milton (Rec #002)	31.7	Highest Second Highest
1981	319	Boston (Rec #082)	34.4	Highest
	124	Boston (Rec #025)	25.3	Highest Second Highest

Note: PSD Increment for a 24-hour average = 91 $\mu g/m^3$.

TABLE 5-4 (REVISED)

HIGHEST 24-HOUR AVERAGE SO_2 PSD INCREMENT CONSUMPTION IN PERIMETER PSD BASELINE AREAS FROM SOURCES MODELED IN THIS STUDY

Year	Day	Location	Concentration($\mu g/m^3$)	Increment Already Consumed ($\mu g/m^3$)	Total($\mu g/m^3$)
1977	269	N. Andover	8.3	19.0	27.3
	193	Methuen	7.8	15.6	23.4
	325	Lawrence	9.2	43.0	52.2
	114	Natick	14.1	79.0	93.1
1978	009	N. Andover	13.4	19.0	32.4
	128	Methuen	7.7	15.6	23.3
	008	Lawrence	9.4	43.0	52.4
	236	Natick	17.6	79.0	96.6
1979	147	N. Andover	17.8*	19.0	36.8
	117	Methuen	11.3*	15.6	26.9
	117	Lawrence	11.5	43.0	54.5
	060	Natick	22.7*	79.0	101.7
1980	243	N. Andover	6.7	19.0	25.7
	101	Methuen	10.0	15.6	25.6
	101	Lawrence	8.0	43.0	51.0
	127	Natick	14.9	79.0	93.9
1981	033	N. Andover	17.7	19.0	36.7
	135	Methuen	6.4	15.6	22.0
	135	Lawrence	15.0*	43.0	58.0
	142	Natick	15.7	79.0	94.7

Note: PSD increment for a 24-hour average = 91 $\mu g/m^3$.

* Highest 24-hour PSD increment consumption in this city/town for the 5-year modeling period.

TABLE 5-5 (REVISED)

HIGHEST 24-HOUR AVERAGE SO_2 PSD INCREMENT CONSUMPTION RESULTING FROM INTERACTION OF MYSTIC AND NEW BOSTON WITH NATICK PAPERBOARD

Year	Day	Location with Respect to Natick Paperboard	Interaction	Total Concentration (μg/m^3)
1977	114	1.0 km SW	Mystic/N. Paper	18.8
	222	0.6 km WSW	New Boston/N. Paper	16.0
	336	0.8 km ENE	N. Paper Max Impact (No Interaction)	84.6 (75.6)*
1978	236	1.0 km SW	Mystic/N. Paper	23.6
	236	0.8 km WSW	New Boston/N. Paper	19.9
	357	0.8 km ENE	N. Paper Max Impact (No Interaction)	61.2
1979	060	1.0 km SW	Mystic/N. Paper	25.0
	128	0.8 km WSW	New Boston/N. Paper	21.7
	166	0.8 km ENE	N. Paper Max Impact (No Interaction)	62.6
1980	119	1.0 km SW	Mystic/N. Paper	20.0
	127	0.8 km WSW	New Boston/N. Paper	18.6
	205	0.8 km ENE	N. Paper Max Impact (No Interaction)	71.9
1981	142	1.0 km SW	Mystic/N. Paper	20.1
	142	0.6 km WSW	New Boston/N. Paper	17.7
	351	0.8 km ENE	N. Paper Max Impact (No Interaction)	88.2

Note: PSD increment for a 24-hour average = 91 μg/m^3.

*Highest-second-highest concentration at Walnut Hill over the 5-year period.

TABLE 5-6 (REVISED)
HIGHEST ANNUAL AVERAGE PSD INCREMENT CONSUMPTION IN PRIMARY PSD BASELINE AREAS FROM SOURCES MODELED IN THIS STUDY

Year	Location	Concentration (µg/m3)
1977	Boston-Milton Boundary (Rec #006)	1.5
1978	Boston Harbor (Rec #125)	1.3
1979	Boston Harbor (Rec #125)	0.8
1980	Boston-Milton Boundary (Rec #006)	1.4
1981	Boston-Milton Boundary (Rec #006)	1.1

Note: PSD Increment for annual average = 20 µg/m^3.

TABLE 5-7 (REVISED)

HIGHEST ANNUAL AVERAGE SO_2 PSD INCREMENT CONSUMPTION IN PERIMETER PSD BASELINE AREAS FROM SOURCES MODELED IN THIS STUDY

Year	Location	Concentration(μg/m^3)	Increment Already Consumed (μg/m^3)	Total(μg/m^3)
1977	N. Andover	-0.2	1.8	1.6
	Methuen	0.2	1.4	1.6
	Lawrence	0.1	9.2	9.3
	Natick	0.3	8.0	8.3
1978	N. Andover	0.4	1.8	2.2
	Methuen	0.2	1.4	1.6
	Lawrence	0.3	9.2	9.5
	Natick	0.5	8.0	8.5
1979	N. Andover	0.5	1.8	2.3
	Methuen	0.2	1.4	1.6
	Lawrence	0.2	9.2	9.4
	Natick	0.4	8.0	8.4
1980	N. Andover	0.0	1.8	1.8
	Methuen	0.1	1.4	1.5
	Lawrence	0.1	9.2	9.3
	Natick	0.1	8.0	8.1
1981	N. Andover	0.5	1.8	2.3
	Methuen	0.2	1.4	1.6
	Lawrence	0.3	9.2	9.5
	Natick	0.1	8.0	8.1

Note: PSD increment for a annual average = 20 μg/m^3.

CONCEPTUAL DESIGNS

APPENDIX D

ATMOSPHERIC DISPERSION REMODELING WITH REFINED CONCEPTUAL DESIGNS

APPENDIX D

ATMOSPHERIC DISPERSION REMODELING WITH REFINED CONCEPTUAL DESIGNS

Atmospheric dispersion modeling utilized in the determination of the ambient air quality impacts is dependent upon the designs of the New Boston and Mystic Stations, specifically as they relate to chimney and flue gas parameters, and pollutant emission rates. The description of operational air quality impacts in Section 7.1.2 is based on preliminary conceptual design parameters shown in Table 7.1-9. A more refined conceptual design for each station indicates several modifications to these parameters. Table D-1 shows the modeling input parameters associated with the refined conceptual designs.

In an effort to determine any changes in predicted ambient air quality impacts that would occur due to the refined conceptual designs, a remodeling analysis was undertaken. The remodeling was initially limited to the two pollutants of greatest emissions: sulfur dioxide (SO_2) and nitrogen oxides (NOx). Since the SO_2 and NOx remodeling results show small changes from the original modeling associated with the preliminary conceptual designs, remodeling for all other pollutants (e.g., particulate matter, trace elements) was unnecessary. This is particularly relevant since a net improvement in ambient air quality during coal firing was predicted for most pollutants and averaging periods in the original modeling. A summary of the results of remodeling for SO_2 and NOx follows.

Sulfur Dioxide (SO_2)

The SO_2 emission rates at New Boston and Mystic Stations due to the refined conceptual design are shown in Table D-1. In comparison to Table 7.1-9, it can be seen that the SO_2 emission rate increases slightly at New Boston Station, but decreases at Mystic Station.

Tables D-2 and D-3 present the remodeled highest 24-hour average SO_2 concentrations predicted during coal firing inside and outside the primary prevention of significant deterioration (PSD) baseline areas. In comparing these concentrations to the original modeling values shown in the analogous Tables 7.1-10 and 7.1-11, it can be seen that the highest and the highest-second-highest concentrations and locations for the 5 years analyzed changed only slightly. In many instances, the concentrations have decreased slightly due to the refined conceptual designs. The maximum highest-second highest SO_2 concentration predicted for the 5-year meteorological period decreased from 183.1 ug/m^3 to 181.9 ug/m^3 inside the primary PSD baseline area, and from 231.2 ug/m^3 to 230.2 ug/m^3 outside the primary PSD baseline area.

Similar to Tables 7.1-10 and 7.1-11, Tables D-2 and D-3 clearly show that the primary 24-hour standard would be maintained by a wide margin with firing an average 1.5 percent (30-day average) sulfur content coal at Mystic and New Boston Stations.

Further analysis of the remodeling results indicates that the 24-hour SO_2 standard would be maintained if the 24-hour average sulfur content were not to exceed 4.7 percent at Mystic Station, and 4.3 percent at New Boston Station. The original modeling indicated that the 24-hour standard would not be violated for coal with a sulfur content up to 4.6 percent at all five candidate coal conversion units.

To ensure that the original 3-hour SO_2 modeling results are not significantly changed by the refined conceptual designs, a reevaluation was performed. The results continue to show the 3-hour secondary standard of 1300 ug/m^3 would be maintained by a wide margin with a 1.5 percent (30-day average) sulfur content coal. The standard would not be violated with 3-hour average sulfur content up to 4.4 percent at New Boston Station, and 5.0 percent and greater at Mystic Station. This compares to a 3-hour average sulfur content of 4.6 percent in all candidate units for the preliminary conceptual designs.

Table D-4 provides the remodeling results for annual average SO_2 concentrations. A comparison to the original modeling results shown in Table 7.1-12 demonstrates that the highest total annual SO_2 concentrations predicted for each of the 5 years modeled remain nearly the same. The maximum projected annual average concentration for Metropolitan Boston, where the Mystic and New Boston Stations are known to have a contribution, changes slightly from 52.9 ug/m^3 to 54.0 ug/m^3. This continues to compare favorably with and be well within the 80 ug/m^3 annual standard.

A summary of the highest predicted SO_2 increment consumption in the areas where PSD baseline has been set is presented in Table D-5. In comparison to the original results shown in Table 7.1-13, it is evident that highest 3-hour increment consumption from New Boston and Mystic Stations is slightly less with the refined conceptual designs. Essentially no changes have occurred in either the 24-hour or annual average increment consumption in the PSD baseline areas.

In summary, the remodeling assessment performed to determine any net effect of the refined conceptual designs on predicted ambient SO_2 impacts demonstrates that insignificant changes occur in the predicted maximum ambient concentrations and locations from those predicted for the preliminary conceptual designs.

Nitrogen Dioxide (NO_2)

The remodeling analysis also included the effects of refined conceptual designs on short-term NO_2 concentrations, specifically as they relate to the 1-hour Massachusetts NO_2 guideline. Coal-firing emissions of NOx for the refined conceptual designs at Mystic and New Boston Station are 2315 lb/hr and 5520 lb/hr, respectively. Results of the reassessment of NOx emissions, shown in Table D-6, indicate that 1-hr NO_2 net impacts at three of the five NO_2 monitoring sites (Kenmore Square, Tufts University, Victory Field) increase slightly due to the refined conceptual designs. Concentrations decrease slightly at the Callahan Tunnel monitor and remain the same at the Bremen Street monitor. The combined New Boston and Mystic Station net impact at the two "hot spot" monitoring locations (Kenmore Square and Callahan Tunnel) will continue to be well within the "significant impact" level of 32 ug/m^3. In addition, the combined New Boston and Mystic Stations' maximum impacts do not cause any exceedances of the 1-hour guideline of 320 ug/m^3 at monitoring locations where background levels of NO_2 exist (Bremen Street, Tufts University, and Victory Field).

The maximum 1-hour NO_2 net increase of 63.4 ug/m^3 for the preliminary conceptual designs is predicted to be 69.7 ug/m^3 for the refined conceptual designs. Even conservatively assuming the second highest recorded background concentration (207 ug/m^3 at Bremen Street) occurs at the same receptor as the maximum net impact (receptor 114), the total concentration (net impact plus background) does not exceed the Massachusetts 1-hour NO_2 guideline of 320 ug/m^3 (see Table D-6).

Reanalysis of the annual average NO_2 net impact in Metropolitan Boston was not necessary in light of the small changes in the short-term impacts associated with the refined conceptual designs, and the predicted net improvement in annual average NO_2 concentrations associated with the preliminary conceptual designs.

All the conservative assumptions identified in the original modeling analysis in determining NO_2 impacts (see Section 7.1.2.3) are incorporated into the reassessment of NO_2 impacts for the refined conceptual designs.

In summary, the remodeling assessment performed to determine the net effect of the refined conceptual designs on predicted 1-hour NO_2 impacts demonstrates that insignificant changes occur in the predicted maximum ambient concentrations. Because of the insignificant changes in the short-term impacts, a reanalysis for annual average NO_2 concentrations was not necessary.

Reanalysis of Other Pollutants

Due to results of remodeling for SO_2 and NO_2 indicating little or no change in postconversion predicted ambient air quality between the refined conceptual designs and the preliminary conceptual designs, a reanalysis for all other pollutants is determined not to be warranted. Modeling associated with the preliminary conceptual designs demonstrated a net improvement in air quality for many pollutants and a negligible degradation for other pollutants. Conclusions reached in a reassessment of these pollutants would therefore not have changed.

TABLE D-1

CHIMNEY AND FLUE GAS PARAMETERS AND SO_2 EMISSION RATES FOR PROPOSED COAL FIRING AT NEW BOSTON AND MYSTIC STATIONS FOR THE REFINED CONCEPTUAL DESIGNS(1)

Station	Fuel	Unit	Chimney Height (m)	Flue Gas Temperature (°K)	Flue Gas Exit Velocity (m/sec)	Chimney Diameter (m)(4)	SO_2 Emission Rate (g/sec)	
							Maximum	Annual
Mystic	1.5% S Coal	4,5, and 6(2)	152.4	408	28.5	5.36	1216.0	1216.0
New Boston	1.5% S Coal	1 and 2(3)	112.5	413	27.4	7.10	2174.0	2174.0

NOTES:

1. This table is analogous to Table 7.1-9.
2. Mystic Units 4 and 5 boilers are each rated at 1237 MBtu/hr. Unit 6 boiler is rated at 1385 MBtu/hr.
3. New Boston Units 1 and 2 boilers are each rated at 3450 MBtu/hr.
4. These values represent the equivalent diameter, which is the diameter of a hypothetical chimney whose exit area is the total exit area for the actual number of flues.

TABLE O-2

HIGHEST 24-HOUR AVERAGE SO_2 CONCENTRATIONS PREDICTED IN THE PRIMARY PSD BASELINE AREA FOR THE REFINED CONCEPTUAL DESIGNS (1.5 PERCENT SULFUR CONTENT COAL) (1)

Year	Day	Receptor Location (2)	Concentrations (ug/m^3) (3)	Category
1977	054	Boston/Brookline Bdy (Rcpt #082)	162.5	Highest
	287	Boston/Brookline Bdy (Rcpt #082)	160.5	Highest-Second Highest
1978	037	Boston (Rcpt #158)	198.0 (4)	Highest
	048	Boston Harbor (Rcpt #037)	164.2	Highest-Second Highest
1979	050	Milton, Great Blue Hill (Rcpt #001)	195.8	Highest
	057	Boston, Hyde Park (Rcpt #005)	154.3	Highest-Second Highest
1980	015	Milton, Hancock Hill (Rcpt #002)	191.1	Highest
	016	Milton, Hancock Hill (Rcpt #002)	181.9 (5)	Highest-Second Highest
1981	015	Milton (Rcpt #008)	201.1	Highest
	016	Boston Harbor (Rcpt #076)	164.8	Highest-Second Highest

NOTES:

1. This table is analogous to Table 7.1-10. The 1.5 percent sulfur coal is a 30-day average.
2. See Appendix C for coordinates of receptors.
3. 24-hour ambient air quality standard is 365 ug/m^3.
4. This represents the severe meteorological conditions during the 1978 blizzard.
5. Highest-second highest concentration for the 5-year meteorological period for receptors within the primary PSD baseline area. This day, receptor and concentration are also the limiting case for the complying fuel calculation for both Mystic and New Boston.

Rcpt = Receptor

Bdy = Boundary

TABLE D-3

HIGHEST 24-HOUR AVERAGE SO_2 CONCENTRATIONS PREDICTED OUTSIDE THE PRIMARY PSD BASELINE AREA FOR THE REFINED CONCEPTUAL DESIGNS (1.5 PERCENT SULFUR CONTENT COAL) (1)

Year	Day	Receptor Location (2)	Concentrations (ug/m^3) (3)	Category
1977	034	Beverly (Rcpt #275)	238.6	Highest
	069	Manchester (Rcpt #276)	230.2 (4)	Highest-Second Highest
1978	195	Beverly (Rcpt #275)	235.7	Highest
	024	Beverly (Rcpt #275)	203.5	Highest-Second Highest
1979	060	Salem/Peabody Bdy (Rcpt #225)	263.2	Highest
	346	Beverly (Rcpt #275)	202.3	Highest-Second Highest
1980	353	Manchester (Rcpt #276)	276.2	Highest
	050	Beverly (Rcpt #275)	185.5	Highest-Second Highest
1981	015	Salem/Peabody Bdy (Rcpt #225)	247.5	Highest
	054	Salem/Peabody Bdy (Rcpt #225)	229.4	Highest-Second Highest

NOTES:

1. This table is analogous to Table 7.1-11. The 1.5 percent sulfur coal is a 30-day average.
2. See Appendix C for coordinates of receptors.
3. 24-hour ambient air quality standard is 365 ug/m^3.
4. Highest-second highest concentration for the 5-year meteorological period for receptors outside of the primary PSD baseline area.

Rcpt = Receptor

Bdy = Boundary

TABLE D-4

HIGHEST ANNUAL AVERAGE SO_2 CONCENTRATIONS PREDICTED IN THE PRIMARY PSD BASELINE AREA FOR THE REFINED CONCEPTUAL DESIGNS(1)

Year	Receptor Location(2)	Source Contributions(ug/m³) Modeled Sources(3)	Source Contributions(ug/m³) Monitored Background(4)	Total (ug/m³)(5)
1977	Boston (Rcpt #135)	14.9	38.0	52.9
1978	Boston Harbor (Rcpt #057)	14.0	40.0	54.0
1979	Boston (Rcpt #135)	13.0	35.9	48.9
1980	Boston Harbor (Rcpt #038)	14.1	35.2	49.3
1981	Boston Harbor (Rcpt #057)	14.3	33.9	48.2

NOTES:

1. This table is analogous to Table 7.1-12.
2. See Appendix C for coordinates of receptors.
3. Modeled sources include the contribution from all other major sources of SO_2 in Metropolitan Boston. See Section 7.1.
4. Represents a regional annual average background concentration as it is the average of all hourly monitored values for that particular year.
5. Federal and state annual average ambient air quality standard is 80 ug/m³.

Rcpt = Receptor

TABLE D-5

HIGHEST PREDICTED SO_2 INCREMENT CONSUMPTION ASSOCIATED WITH PROPOSED COAL CONVERSION FOR THE REFINED CONCEPTUAL DESIGNS (ug/m^3)(1)

	Highest Incremental Contribution From New Boston and Mystic Stations	Incremental Contribution From Other Sources	Total Projected Increment Consumption(2)	Maximum Allowable PSD Increment
3-Hour Average				
N. Andover	69	42	111	512
Methuen	41	35	76	512
Lawrence	57	115	172	512
Natick	66	199	265	512
24-Hour Average				
N. Andover	18	19	37	91
Methuen	11	16	27	91
Lawrence	15	43	58	91
Natick	15	9	24	91
Annual Average				
N. Andover	0.5	1.8	2.3	20
Methuen	0.2	1.4	1.6	20
Lawrence	0.3	9.2	9.5	20
Natick	0.5	8.0	8.5	20

NOTES:

1. This table is analogous to Table 7.1-13

2. These are the highest projected levels of SO_2 increment consumption with a potential contribution from coal-fired Mystic and New Boston Stations.

TABLE D-6

COMBINED NET CHANGE IN AMBIENT 1-HOUR NO_2 CONCENTRATIONS PREDICTED FOR THE REFINED CONCEPTUAL DESIGNS (ug/m^3) (1)

Monitored Hot Spots	Source Contribution	Background (3)	Total (4)
Kenmore Square	20.1(2)	NA	NA
Callahan Tunnel	14.9(2)	NA	NA
Background Locations			
Bremen Street, East Boston	18.8	207	226
Tufts University Medford	48.1	197	245
Victory Field Watertown	33.6	182	219
Location of Maximum Net Increase			
Receptor 114(5)	69.7	207(6)	277

NOTES:

1. This table is analogous to Table 7.1-14.
2. Less than significant level of 32 ug/m^3.
3. Second highest concentration from Table 5.3-6.
4. State one-hour guideline is 320 ug/m^3.
5. Receptor 114 is located at UTM coordinates 330.00E and 4692.00N, or approximately 1600 feet north of Beacon Hill.
6. No ambient data exists at the maximum impact location. It is assumed that the maximum second-highest concentration recorded at the background monitors exists at the maximum location.

NA - Not applicable in analysis at the monitored hot spots.

APPENDIX E

ASH TRANSPORTATION FOR NEW BOSTON STATION COAL CONVERSION

APPENDIX E

ASH TRANSPORTATION FOR NEW BOSTON STATION COAL CONVERSION

E.1 INTRODUCTION

The purpose of this study is to provide a detailed assessment of the environmental impacts associated with each of the potential alternative modes of coal ash transportation from New Boston Station. The three alternatives evaluated are truck, train, and barge.

The study area includes the potential road, rail, and water thoroughfares connecting New Boston Station with the appropriate regional transportation system. Potential impacts associated with the transport of coal ash once on the appropriate regional transportation system are not discussed since final destinations have not been determined. Furthermore, it is assumed that no significant environmental impact would result from the additional traffic resulting from ash transport on these major routes. The analysis of transportation impacts between these major regional routes and the ultimate destination will be performed as part of the final storage/disposal site selection.

In the analysis of each of the three options, existing and expected base-year (1987) data are presented. 1987 is used as the base-year because it is the expected date of start-up of the first converted unit. Section E.2 provides a general discussion of present and anticipated 1987 land uses including current development proposals for South Boston. Potential environmental impacts for each option, based on estimated truck, train, and barge frequencies, are discussed in detail in Sections E.3, E.4, and E.5, respectively.

E.2 DESCRIPTION OF STUDY AREA

E.2.1 Site Access

The New Boston Station site comprises a 24.2-acre parcel of industrially zoned land along the southern bank of the Reserved Channel of Boston Harbor. New Boston Station is located at the intersection of Summer Street and East First Street. The station is west of the Massachusetts Bay Transportation Authority (MBTA) property that is also industrially zoned and is also used as a power plant site.

Figure E-1 presents the site vicinity. South Boston encompasses a peninsula of approximately 2400 acres or 3.75 square miles.

There are 10 access routes to South Boston from the regional road network. Eight of these access routes require passing over bridges that cross either Fort Point Channel or Conrail, MBTA, or Amtrak railroad tracks. Summer Street, Broadway, and Columbia Road bridges are the major entrance/exit routes to South Boston. Of the 10 entrance points, all but Columbia Road and Day Boulevard serve as entrance points for trucks. Figure E-2 presents entrance points to South Boston.

E.2.2 Land Use

Current land use in South Boston is predominately divided into two zones: a residential zone occupying approximately one-third of the total area, and an industrial zone occupying the remaining two-thirds. East First and West First Street, and Old Colony and Dorchester Avenues serve as the general dividing lines between the two uses. The residential community is located south of East First and West First Streets and east of Old Colony and Dorchester Avenues, an area of approximately 1.7 square miles. The land area of residential use has remained relatively constant over the past few decades.

Industrial uses are found north of East and West First Streets along the waterfront and along Dorchester Avenue. In recent years, industry has been locating south of East First and West First Streets within the residential neighborhoods. Industrial uses intermingled with residential areas are evident along East First and West First Streets, West Second Street, West Third Street, A Street, B Street, and Old Colony Avenue. Major industrial activities located north of East First and West First Streets include manufacturing, shipping, warehousing, construction equipment storage, trucking, and light industry in addition to the power plants. Approximately 35 percent of the land within this industrial area is vacant (BRA 1979).

Independence Square and the Christopher Lee Playground are neighborhood parks located in residential areas in the vicinity of New Boston Station. The Christopher Lee Playground is located across East First Street from the station. The playground has a play area for young children as well as several sports facilities. Independence Square is the site of the Vietnam War Memorial, dedicated to the residents of South Boston who gave their lives in the Vietnam War. These locations represent the most sensitive land use areas in the station vicinity and are shown in Figure E-1.

E.2.3 Road System

South Boston's northern industrial section, which includes New Boston Station, has connections to the Central Artery which, in turn, connects to the regional highway networks to the north, west, and south. To the north, the Mystic/Tobin Bridge and Northeast Expressway (Route 1 and Interstate 95), Interstate 93, and the Callahan Tunnel are all accessible via the Central Artery and local surface streets. To the west, the Massachusetts Turnpike is accessible via the Central Artery, the Broadway Bridge, the Summer Street Bridge, or the West Fourth Street Bridge. Presently, traffic flow on the Summer Street Bridge over the Reserved Channel is temporarily limited to southbound traffic. Regional access to the south from South Boston is provided by the Southeast Expressway, which can be reached via the Central Artery or directly by exiting South Boston from one of the roadways on its southern border. The regional road network is shown in Figure E-3. Road traffic is discussed in Section E.3, Ash Transportation by Truck.

E.2.4 Rail System

Local rail service to South Boston is provided by Conrail on the South Boston industrial track embedded in East First and West First Streets. This track is presently in use at a level of service of 5 nights per week. Freight traffic on this track is discussed in Section E.4, Ash Transportation by Rail.

E.2.5 Waterway System

As shown on Figure E-1, New Boston Station is also accessible by ship and barge via the Reserved Channel of Boston Harbor, which borders the station on the north. The maintained channel is approximately 430 feet wide and is navigable for small craft and barge from the outer harbor to the Summer Street Bridge over Reserved Channel. The Summer Street Bridge is a retractable bridge with a horizontal clearance of 39 feet and a vertical clearance of 6 feet. The present controlling depth of the maintained channel is approximately 32 feet below mean low water. The major destinations for vessels entering the Reserved Channel include the Texaco (White Fuel), Sea-Land Services, Massport's Conley Marine Terminal at Castle Island, and the U.S. Army Base. Some informal use of the Reserved Channel for the mooring of recreation boats takes place west of the Summer Street Bridge over Reserved Channel. Traffic on the Reserved Channel is discussed in Section E.5, Ash Transportation by Barge.

E.2.6 Proposed Development

Several major developments are underway or planned for the industrial portion of South Boston. These include the following seaport-related projects:

1. Fish Pier Renovation - two-stage repair and renovation of the existing Fish Pier structure.

2. Boston Marine Industrial Park (BMIP) and Seaport Facility - ongoing development of BMIP facilities and infrastructure of the 101-acre park, including the reconstruction of two dry docks, designation of a

foreign trade zone, and development of a job training center.

3. U.S. Army Reservation Building 114 - Garment Industry - Economic Development and Industrial Corp (EDIC) sponsored development of the 23-acre complex and marginal wharf to include the garment industry relocation.

4. Conley Marine Terminal at Castle Island - development of an additional 10 acres by modifying and expanding terminal facilities to include an additional 1000 feet of marginal wharf space.

5. Commonwealth Flats - 32.5-acre Massport site - proposed development to serve as storage area for containers landed at the proposed seaport facility.

6. U.S. Naval Recreation Area - proposed development of 15 surplus acres of the 20-acre recreational area for manufacturing and seaport-related activities.

In addition, the following major commercial, industrial, and residential projects are ongoing:

1. Athanas Pier 4 and Fan Piers 1, 2, and 3 - development of 32-acre site to include a residential-commercial complex of high-rise housing, hotel and office space, convention facilities, retail shops, parking spaces, and a marina.

2. Town and City Properties, Inc Project - development of both commercial and residential projects along a 33-acre parcel, parallel to Fort Point Channel.

3. Commonwealth Pier/Boscom Project - renovation of Commonwealth Pier into a high technology exhibition and marketing center, as well as restaurant and hotel space.

The locations of these projects are shown in Figure E-4 and schedules for development are presented in Table E-1. Traffic generated by these projects has been incorporated into projected volumes for 1987.

Additional developments proposed or under consideration for the South Boston area include the development of general warehouse space west of the Reserved Channel by the Boston Harbor Industrial Development Corporation, an MBTA maintenance facility and a Department of Public Works (DPW) garage, the latter two in the Fort Point Channel area. Finally, capital improvement plans by the Gillette Company and Texaco (White Fuel) include plant expansion and access improvement.

Several transportation projects are planned which will improve access to and within South Boston. Those expected to be in place by 1987 include the South Station Transportation Center; traffic flow improvements in Dewey Square; Northern Avenue Bridge rebuilding and realignment; improvements to the Summer Street bridges at Fort Point Channel and A, B, and C Streets; upgrading and repair of the Summer Street Bridge over Reserved Channel; and MBTA Station improvements at Dorchester Avenue and Broadway.

Studies are currently underway for two major projects which would be implemented sometime after 1987. These projects are a Seaport Access road to provide improved truck access to the industrial portion of South Boston and a Third Harbor Tunnel under Boston Harbor to East Boston.

Road improvement projects and their schedules are discussed in Section E.3. Rail and waterborne transportation in the vicinity of New Boston Station are discussed in Sections E.4 and E.5, respectively.

E.3 ASH TRANSPORTATION BY TRUCK

E.3.1 Introduction

In evaluating the probable impacts from the addition of ash truck activity in the study area, the following items were examined:

1. Designated truck routes and traffic volumes for existing and anticipated 1987 base-year conditions
2. The probable impacts due to added traffic from coal ash truck operations

While the current proposals for a Third Harbor Tunnel and Seaport Access are mentioned, no analysis of ash truck impacts has been prepared with these alternatives in place. It is envisioned that if and when any of these developments take place, overall truck traffic impacts in South Boston will be alleviated. Thus, this assessment of the impacts in South Boston is considered conservative. Based on the results of this analysis, recommended measures for mitigation of environmental impacts for the presently envisioned truck traffic in South Boston are discussed in Section E.6.

E.3.2 Existing and 1987 Truck Routes and Traffic

Truck access to New Boston Station exists along several routes. Figure E-5 shows those routes designated for truck access from South Boston Station to the regional highway network, as identified in the Seaport Access System Preliminary Environmental Assessment (Fay et al 1980) and established by the Boston City Traffic and Parking Department.

On the basis of field observations made in March 1983, an evaluation of existing truck routes providing access to and from New Boston Station and the regional access system resulted in the following conclusions:

1. The shortest and most appropriate route for truck traffic bound south or west of New Boston Station includes East First and West First Streets to B Street to West Second Street to Dorchester Avenue, and across the Broadway Bridge. Inbound traffic is required to follow the designated truck route on West Broadway to C Street to West First Street. Due to the added distance and level of traffic along Dorchester Avenue providing access to the Southeast Expressway from Southampton Street via Andrew Square, this route should be considered a secondary alternative.

2. Access to the Central Artery for ash removal trucks bound for sites north of Boston can best be accomplished in one of several ways:

    a. Along East First and West First, B, and West Second Streets to the Broadway Bridge, as described above

    b. Along East First and West First, D, and Summer Streets to Atlantic Avenue

    c. Along East First and West First, D, and Fargo Streets to B Street and then to Congress Street, or Northern Avenue to Atlantic Avenue

        Due to the poor existing condition of B Street, this alternative presently represents an option for avoiding Dewey Square only when conditions warrant, such as during rush hours.

3. Other truck routes, including A, C, and E Streets between West First and Summer Streets currently present less advantageous alternatives due to potential conflicts with warehouse truck traffic.

4. The Summer Street Bridge over Reserved Channel excludes heavy truck traffic and, thus, is not a viable truck route at present.

A number of proposals for bridge and roadway improvements in South Boston are presently being developed. The following improvements are expected to be in place in 1987. These improvements are consistent with those identified in the Building 114, Draft Environmental Impact Report (Vanasse/Hangen 1982) and in local agency development proposals (BRA 1983).

1. Summer Street Bridge over Reserved Channel - structural improvements enabling truck traffic in both directions.

2. Summer Street Bridges which cross Fort Point Channel and A, B, and C Streets - structural improvement.

3. Summer Street and Atlantic Avenue Intersections - traffic flow improvements.

4. Northern Avenue Bridge - reconstruction and relocation of Northern Avenue to B Street.

5. Broadway and Dorchester Avenue Intersection - removal of the MBTA Kiosk.

The locations of these improvements are shown on Figure E-6 in relation to the anticipated 1987 available truck routes. In addressing the potential impacts resulting from truck access to New Boston Station, traffic volumes, levels of service, and accident information presented in the above referenced Seaport Access, Building 114, and the Third Harbor Tunnel reports, Draft Environmental Impact Statement (Mass DPW 1982) was utilized. Additional background information developed for the Seaport Access System study was compiled to provide a basis for assessing the impacts of ash truck traffic along designated truck routes for daily and peak-hour time periods. This data was compared with the estimates of existing and future traffic volumes.

The traffic volume projections presented in these studies were evaluated for consistency. Average daily total traffic and truck volume projections were adjusted to 11-hour (7 am to 6 pm) estimates for the base year, as shown in Table E-3 and Figure E-7.

These base-year average daily 11-hour traffic forecasts reflect the traffic volumes along the truck access routes to and from New Boston Station during scheduled ash removal operations (Monday to Saturday only). Those routes, with the greatest proportion of trucks compared to their total vehicular traffic, are East First and West First Streets with 26 and 55 percent, or 700 and 1750 trucks, respectively. Total traffic volumes along these routes are predicted to be only 2650 and 3200 for the 11-hour period, and thus would be light in comparison with Northern Avenue, Summer Street, or the Broadway Bridge which are expected to handle in excess of 2000 trucks and 20,000 total vehicles.

Peak-hour traffic volumes from existing studies were similarly adjusted to the base year for selected intersections along the designated truck routes. Calculations of the associated morning and evening peak-hour levels of service (LOS) were examined to determine the likely points of congestion. LOS is defined as the measure of operational efficiency for a roadway or intersection where LOS "A" through "F" represent the following:

A - No restriction on operating speed, free-flow

B - Some traffic restrictions on operating speed, stable flow

C - Volume traffic restrictions on operating speed and maneuverability, stable flow

D - Traffic congestion restrictions, unstable flow

E - Traffic volume at or near capacity, unstable flow, stoppages

F - Traffic volume above capacity, downstream restriction, forced flow

LOS designations and the results of this survey are shown on Figure E-8.

During the morning and evening rush hours, the intersections identified as those likely to experience significant reductions in LOS were those at the key access points to South Boston. With a predicted LOS of F for both peak hours, Andrew Square is shown to be a major bottleneck. Likewise, traffic volumes at the intersections of Atlantic Avenue with Northern Avenue, Congress Street, and Summer Street; and traffic volumes at Dorchester Avenue and West Broadway, are predicted to result in unacceptable levels of congestion.

Data on the frequency of traffic accidents at selected locations along designated truck routes was compiled from the Seaport Access System, Third Harbor Tunnel, and Building 114 reports. Results of the examination of this data are summarized in Table E-2. The corresponding locations are shown in Figure E-9. While many of the routes exhibiting the greatest number of recorded accidents are often used by trucks, none of the reports indicate an abnormally high involvement of trucks.

E.3.3 Probable Impacts

After the conversion of New Boston Station Units 1 and 2 to coal, it is estimated that an average of 27 (20 ton total capacity) truckloads of ash per day will be removed from the station. It is assumed that trucking operations will take place between the hours of 7 am and 6 pm, Monday through Saturday. Based on this 11 hours per day, 6 days per week schedule, the average one-way frequency for the loaded vehicles is approximately 2.5 trucks per hour. Since an equal number of unloaded trucks will be returning to New Boston Station each hour to pick up more ash, the total volume of ash disposal trucks passing any point on the study area road network will be approximately 5 trucks per hour or one every 12 minutes. Under conditions of maximum station load, the estimated number of truckloads of ash per day is 39. Thus, under peak conditions, an average of 3.5 truckloads of ash per hour will be required. The total estimated truck volume added to the network under such conditions is 7 per hour or one every 8 to 9 minutes.

Expected increases in traffic volume due to increased truck activity from New Boston Station for the base year were evaluated based on the above estimates. As shown in Table E-3, increases due to ash trucks on total traffic volumes for the various designated truck routes are relatively low, ranging from a 0.3 to a 2.0 percent increase under average loading conditions. Under maximum loading conditions, the increase over total traffic is between 0.4 and 2.9 percent. The greatest increases are observed on East First and West Second Streets where the average daily traffic volumes are relatively low. Daily truck traffic increases due to ash trucks from New Boston Station are 2.8 to 9.8 percent under average conditions, and 4.0 to 14.2 percent under maximum conditions.

The three instances where truck traffic volume increases would be greater than 7 percent are locations with relatively low traffic volumes and excess capacity. The existing levels of service in these locations can accommodate additional vehicles and, therefore, the additional trucks for ash transport are not expected to have a significant impact.

Based on these relatively small increases in truck traffic along the designated truck routes, impacts on LOS for the major intersections identified in Section E.3.2 would not be significant during the peak hours. Likewise, for the off-peak hours when most of the truck traffic associated with ash removal would be on the road, total hourly volumes of 5 to 7 vehicles traveling to and from New Boston Station represent a minimal impact.

In terms of safety, the added number of trucks on designated truck routes would not impose a significant increase in the accident risk factor. Future improvements in the road network are expected to further minimize such risks.

Air quality impacts due to the operation of ash trucks in the vicinity of New Boston Station will be minor. Exhaust emissions from diesel engines have the same general characteristics of gasoline engine exhaust. However, diesel engines allow for more complete combustion than gasoline engines, and as a result, hydrocarbon and carbon monoxide (CO) emissions are relatively low. Emissions of nitrogen oxides (NOx) are relatively higher from diesel engines because of the high temperatures and the amount of oxygen involved in diesel combustion, as compared to gasoline combustion (EPA 1973). Table E-7 lists the estimated emissions of particulate matter (PM), CO, hydrocarbons, and NOx from the ash trucks and vehicle traffic along the alternative truck routes, based on U.S. Environmental Protection Agency (EPA) emission factors.

The emissions calculated are representative of the travel distance from New Boston Station to the primary highway, based on traffic volume surveys, and ash transport traffic during normal and peak-plant conditions. During peak-plant conditions, daily emissions from the ash trucks are estimated to be in the range of 1 to 10 percent for PM and NOx, and 0.1 to 1.5 percent for CO and hydrocarbons of the emissions from vehicle traffic. The impact of this emission increase on existing ambient air quality is expected to be minimal. During the transportation of the ash, fugitive PM emissions are not expected since the ash will be moist and the cargo area will be covered, or the ash will be in sealed tank trucks.

Noise impacts due to the operation of ash trucks in the vicinity of New Boston Station will be minor. Fly ash and bottom ash removal will require approximately 27 truck trips per day, 11 hours per day (7 am to 6 pm), 6 days per week. This represents a negligible increase in the truck traffic on East First, West First, and Summer Streets (typically in the order of 1000 trucks per day) and, as with the other truck routes, will not result in noticeable changes in daytime noise levels in the area.

Based on the evaluation of probable impacts, the recommended base-year truck routes are shown in Figure E-10. It is envisioned that the East First to West First Street/Second Street route to the Broadway Bridge will remain the most suitable means of access to the Southeast Expressway for travel to sites to the south and west. The return route will follow the designated truck route along West Broadway to C Street to West First Street. Access to the Central Artery is expected to be improved once the Summer Street Bridge over Reserved Channel is upgraded to handle truck traffic. Thus, for travel north of Boston, Summer Street to Atlantic Avenue, or alternately, East First and West First Streets, to D Street to Fargo Street and the new Northern Avenue Bridge will provide the most suitable routes. The return route will be the same. In view of the predicted traffic congestion during the peak hours at the major intersections along Dorchester and Atlantic Avenues, measures to minimize the potential impacts of ash trucks are being considered. These are discussed in Section E.6.

E.4 ASH TRANSPORTATION BY RAIL

E.4.1 Introduction

Rail freight service to South Boston is provided by Conrail and is available to New Boston Station along East First Street. Limitations onsite (available space and the arrangement of station facilities), as well as the noise generated by train movement and the proximity to residential development, preclude the use of rail for the transport of ash.

E.4.2 Existing and Base-Year Conditions

In the vicinity of the station, west of Summer Street, the South Boston Industrial Track has turnouts to Boston Harbor Industrial Park between E Street and Industrial Park Drive, Felton & Son Distillers at G Street, and the King Warehouse at K and Elkins Street. East of Summer Street, the track provides direct rail access to Boston Molasses Company and Conley Marine Terminal at Castle Island. Massport has the deeded right-of-way to the track, which in 1983 was not in use. Rail facilities are shown in Figure E-11.

In 1983, rail freight service in the vicinity of New Boston Station was limited to one trip daily (Monday through Friday) to Boston Harbor Industrial Park and three times weekly to King Warehouse (Conrail 1983). Use of the rail line is subject to interference from vehicular traffic because the tracks are embedded in the pavement. Trains currently run only at night to avoid truck and commuter traffic. No estimates are available of use of the line in the vicinity of New Boston Station in 1987, and so 1983 rail service data are used as base year data. The estimated 1987 rail traffic on First Street (assuming rail is used for ash transport) is shown in Table E-4. Table E-4 indicates that ash transport by rail would add significantly to the expected base year rail traffic on East First Street.

Transport of ash by rail from New Boston Station would require construction of a turnout into the station utilizing the MBTA property across East First Street from the Christopher Lee Playground. Since available onsite space is limited, it is expected that between 8 and 11 empty, covered, 70-ton hopper cars would have to be brought into the station 6 nights per week and the loaded cars taken out. A small tractor would be utilized onsite to shift the empty cars into position for loading.

E.4.3 Probable Impacts

Train movements result in noise from coupling impacts, wheel/rail squeal, and engine acceleration. Rail transportation would bring a train engine within 120 feet of nearby residences, which is expected to result in a condition of noise pollution as defined in the City of Boston Regulations for the Control of Noise (City of Boston 1975). Significant impact from the noise of the trains is expected because train movement will be on East First Street east of Summer Street at night when ambient noise levels are relatively low and because considerable switching would be required to move the empty and full hopper cars in and out of the station area.

The impact of the exhaust emissions from rail transport on existing ambient air quality is expected to be minimal. No fugitive PM emissions are expected since the ash will be moist and in covered cars.

In order to provide station area tracking in accordance with Conrail requirements, a significant redesign of station facilities would be required.

Transport of ash by rail would represent a significant increase in rail traffic, incursion onto a section of track not currently in use, and generation of annoying noise at night. The impact of ash transport by train would be very significant on the neighboring residential area, and it is concluded that rail transport of ash does not represent a viable alternative at this time.

E.5 ASH TRANSPORTATION BY BARGE

E.5.1 Introduction

Mooring and dock facilities at New Boston Station will be capable of handling coal vessels and ash barges. It is expected that one 5000-ton barge every 7 to 11 days will be required for ash transport. During daylight hours, one or more tugboats will bring in an empty barge and take out the loaded one.

Barge and barge loading facilities for ash transportation will be located in the BECO inlet on the Reserved Channel within the United States Pierhead and Bulkhead Line, west and south of the coal vessel mooring area. The Reserved Channel is approximately 1500 feet west of the main shipping channel entering Boston Harbor. As shown in Figure E-12, the Reserved Channel terminates at Industrial Park Drive in the Boston Harbor Industrial Park, west of the Summer Street Bridge over the Reserved Channel.

E.5.2 Existing and Base Year 1987 Conditions

In addition to New Boston Station dock, other dock facilities on the Reserved Channel are shown in Figure E-12. These include Conley Marine Terminal at Castle Island, Texaco (White Fuel), Sea-Land Service, and the U.S. Army Base, currently leased to the Massachusetts Port Authority (Massport).

Approximately 120 vessels per year enter the Reserved Channel bound for Conley Marine Terminal, Texaco (White Fuel), or Sea-Land Services (Halligan 1983). This total represents an average of 2.3 vessels per week. Included in this number are ships bringing fuel oil to Texaco (White Fuel) for use at New Boston Station. Since no projections are available, the same number of vessels is used as the weekly average for these facilities in 1987.

Although new container port facilities were developed by Massport at the Conley Marine Terminal in 1981, the anticipated expansion of shipping has not occurred. Labor contract disputes have prevented the new facilities from opening. As a result, shipping activity as of 1983 is declining, and it is not known when the terminal will be in full operation (Halligan 1983).

As shown in Table E-5, traffic in the Reserved Channel in 1987 is expected to include an average of one coal vessel per week to New Boston Station. Ash transport by barge is expected to require an average of one barge every 10 to 11 days or a maximum of one barge every 7 to 8 days. These represent weekly averages of 0.6 and 0.9 barge trips, respectively.

By 1987, it is possible that the currently proposed Reserved Channel Marina will be in operation on a site west of Summer Street and north of East First Street (Comm of Mass 1982; Scanlon 1983). However, since these small craft are not expected to interfere with shipping in the Reserved Channel, a designated port facility, they are not included in 1987 totals for vessel traffic in the Reserved Channel.

A long-range proposal to bring a U.S. Navy Surface Action Group (SAG) to the U.S. Army Base is in the preliminary stages. A formal proposal was prepared by Massport and the Economic Development and Industrial Corporation (EDIC), and submitted to the U.S. Navy in the spring of 1983 (City of Boston 1983).

SAG ships are expected to be in port 2 to 3 months of the year, and at sea 9 months. SAG ships are not expected to generate a significant amount of traffic in the Reserved Channel. Since this proposal is only in the preliminary stages, vessel trips are not included in 1987 totals for vessel traffic in the Reserved Channel.

E.5.3 Probable Impacts

As shown in Table E-5, ash transport by barge would add a small number of trips to an already low level of use in the Reserved Channel. The maximum expected frequency of one ash barge every 7 to 8 days means an estimated 48 barge trips in and out of the Reserved Channel each year. In 1980, the Port of Boston received approximately 8200 vessels (COE 1980). Approximately 10 percent of these vessels were barges. Ash transport from New Boston Station would represent an increase of 6 percent in the number of barges in the Port of Boston, and less than 1 percent in the total number of vessels. Boston Harbor vessel traffic in 1980 is presented in Table E-6.

Land uses adjoining the Reserved Channel are waterfront transport, recreation, and industry. None is considered to be a sensitive land use. Noise-sensitive residential areas are located 1000 to 1500 feet south of anticipated barge transport lanes. Barges are moved by tugboat, and this activity is not expected to generate any significant noise impacts.

The impact of exhaust emissions from the transport of one barge per week is expected to be insignificant, and it is anticipated that exhaust emissions will cease once the barge is dockside. Also, fugitive PM emissions are not expected since the ash will be moist.

Boston Harbor is rarely closed due to storms, ice, or fog (Aylward 1983; Rock 1983). Therefore, ash transport by barge is unlikely to be affected by weather conditions. The impacts associated with barge transport of ash are expected to be minimal.

E.6 SUMMARY - MEASURES TO MITIGATE POTENTIAL IMPACTS OF ASH TRANSPORTATION

The potential impacts associated with various modes of transporting coal ash from New Boston Station have been identified in Sections E.3 through E.5. Possible measures to reduce the potential impacts for truck, rail, and barge transport are discussed in the following subsections.

E.6.1 Truck Transport

As discussed in Section E.2, the additional truck traffic due to ash transportation operations at New Boston Station will represent a negligible impact in anticipated base-year traffic along designated truck routes in South Boston. In addition, future improvements in roadway access to South Boston, including one or more of the options proposed in the Seaport Access System and Third Harbor Tunnel reports, will further reduce the impacts of truck traffic in South Boston.

The following measures to minimize the impact of ash trucks from New Boston Station will be considered:

1. Whenever possible, truck travel to and from New Boston Station will be scheduled to avoid the peak-hour congestion identified in Section E.3.

2. Truck routes will be selected to enable expeditious access to the regional transportation system along designated truck routes. The impacts on traffic from new and proposed developments along Summer Street and Northern Avenue will continue to be considered after the conversion.

3. Alternatives for improved access to South Boston will be monitored and employed as they become available.

Ash transportation vehicles will be maintained and operated in accordance with appropriate state and local regulations. Only routes designated for truck traffic will be used.

Potential noise impacts from the operation of ash trucks at New Boston Station, while assessed as being negligible, will be limited in accordance with the 11-hour (7 am to 6 pm) daytime schedule. Vehicles will be equipped and maintained with the required exhaust mufflers. Furthermore, the anticipated truck routes generally avoid residential areas.

E.6.2 Rail Transport

As discussed in Section E.4, the feasibility of transporting coal ash by rail is severely limited by the space available onsite for storing and handling rail cars, the arrangement of station facilities, Conrail design requirements, and the expected noise impacts of train operation on nearby residences and sensitive land uses. Since it is concluded that the transport of ash by rail from New Boston Station is an unacceptable option, mitigation measures are not considered.

E.6.3 Barge Transport

Since the impacts of potential barge transport as identified in Section E.5 are negligible, mitigation measures are not needed.

E.7 REFERENCES

Aylward, Anne. Assistant Port Director, Planning, Massport, Boston, MA. March 14, 1983.

Boston Redevelopment Authority (BRA). South Boston District Profile and Proposed 1979-1981 Neighborhood Improvement Program. 1979

Boston Redevelopment Authority (BRA). Notes of Conference Regarding Development and Road Improvement Projects in South Boston. Collins, E.; Koff, L.; and Robinson, K. Boston, MA. March 15, 1983.

City of Boston Regulations for Control of Noise. 1975.

Commonwealth of Massachusetts (Comm of Mass), Executive Office of Environmental Affairs. Environmental Notification Form, Reserved Channel Marina. Boston, MA. October 1982.

Consolidated Rail Corporation (Conrail). Freight Sales Department. Canton, MA. March 1983.

Fay, Spofford, and Thorndike, Inc, and Wallace Floyd, Ellenzweig, Moore, Inc. Seaport Access System, South Boston, MA. Preliminary Environmental Assessment. June 1980.

Halligan, Joseph. Assistant Manager, Conley Marine Terminal, South Boston, MA., Personal Communication with Ellis, C. March 22, and March 29, 1983.

Massachusetts Department of Public Works (Mass DPW), Massachusetts Turnpike Authority and U.S. Department of Transportation, Federal Highway Administration. Third Harbor Tunnel Project, Interstate 90. Boston, Massachusetts - Draft Environmental Impact Statement/Report - Appendix 4 - Traffic. December, 1982.

Rock, Lieutenant Commander. Port Operations Officer, US Coast Guard, Boston, MA. March 14, 1983.

Scanlon, J. BSC Engineering, Boston, Massachusetts. April 1, 1983.

The City of Boston and the Commonwealth of Massachusetts. U.S. Navy Homeporting Project, Boston, Massachusetts. March 1983.

U.S. Army Corps of Engineers (COE), Waterborne Commerce of the United States. 1980.

U.S. Environmental Protection Agency (EPA). Compilation of Air Pollutant Emission Factors, AP-42, Section 3.1, Highway Vehicles. December 1975 and May 1978.

U.S. Environmental Protection Agency (EPA). Compilation of Air Pollutant Emission Factors, AP-42, Section 3.2, Off-Highway Mobile Services. April 1973.

Vanasse/Hangen Associates, Inc. Building 114 Renovation, Boston Army Base, Boston, Massachusetts - Draft Environmental Impact Report. December 1982.

TABLE E-1

PROPOSED DEVELOPMENTS IN SOUTH BOSTON

Development Project (1)	Type of Development	Developer	Development Schedule	Estimated Cost of Development ($ millions)
Seaport Access System	Transportation planning project	Boston Redevelopment Authority and Massport	1978-ongoing	NA (2)
Northern Ave Bridge Reconstruction	Ongoing repair and reconstruction project	City of Boston, Department of Public Works	1978-ongoing	$12
South Station Transportation Center	Redevelopment project to expand mass-transit facilities and services	Massachusetts Bay Transportation Authority	1979-ongoing	$76
Fish Pier Renovation	Two-stage repair and renovation of existing structure	Massport	1978-ongoing	$16
BMIP & Seaport Facility	Ongoing development of industrial park facilities, and development of marine terminal for containerport operation	Massport	1983-1995	$60 to $90
U.S. Army Renovation/Garment Industry	Conversion of Army Base Building 114 to garment/industrial uses	Economic Development and Industrial Corporation/Boston	1982-1984	$30
Anthanas Pier 4 and Fan Piers 1, 2, and 3	Phased development of residential-commercial high-rise hotel and office space, convention facilities, retail shops, parking, and marina	Anthony's Pier 4 Incorporated	1984-1992	$200
Commonwealth Pier/Boscom Project	Renovation of Commonwealth Pier into a high-technology exhibition and marketing center, and hotel and restaurant space	FMR Properties Incorporated	1983-ongoing	$85
New Boston Station Units 1 and 2 Coal Conversion	Conversion of electric generating Units 1 and 2 at New Boston Station from oil to coal	Boston Edison Company	1984-1988	$513

NOTES:

1. Development locations shown in Figure E-4.
2. NA - not available

TABLE E-2

TRAFFIC ACCIDENT SUMMARY ALONG DESIGNATED TRUCK ROUTES (1)

Intersection	Seaport Access (2) Average 1973 to 1975	Third Harbor Tunnel (2) Average 1978 to 1980	Building 114 (2) Average 1979 to 1980
Northern Avenue and Sleeper Street	-	8	-
Northern Avenue and Atlantic Avenue			24
Congress Street and A Street	-	4	-
Congress Street and Atlantic Avenue	-	-	22
Summer Street and Viaduct	4	-	4
Summer Street and D Street	6	10	7
Summer Street and Harbor Street	1	-	6
East First, Summer and L Streets	3	7	-
West First and D Streets	1	-	-
West Second and A Streets	5	-	-
Dorchester Avenue and Broadway	8	9	-
Broadway and Frontage	-	-	16
Dorchester Avenue and West 4th Street	4	10	-
Dorchester Avenue, A and West 5th Street	3	10	5
Andrew Square	11	8	-

NOTES:

1. Accident locations shown in Figure E-9.
2. See References in Section E.7.

TABLE E-3

ESTIMATED IMPACT OF ASH TRUCKS ON AVERAGE DAILY TRAFFIC IN 1987

		Estimated 11-Hr Traffic Volumes (2)		% Increase of Traffic Due to Ash Trucks			
				Average Round Trips-54		Maximum Round Trips-78	
Road Link (1)	Adjusted 1987 Average Daily Traffic (% Trucks)	Total	Truck	% of Total	% Truck	% of Total	% Truck
1. Northern Avenue Bridge	32,130 (3) (9)	21,850	1,950	0.3	2.8	0.4	4.0
2. Congress Street at Fort Point Channel	12,640 (3) (15)	8,600	1,300	0.6	4.2	0.9	6.0
3. Summer Street at Fort Point Channel	29,990 (3) (9)	20,400	1,850	0.3	2.9	0.4	4.2
4. Summer Street	25,780 (3) (8) (5)	17,550	1,400	0.3	3.9	0.4	5.6
5. D Street	12,380 (3) (13)	8,400	1,100	0.6	4.9	0.9	7.1
6. East First Street West of L Street	3,931 (4) (26)	2,650	700	2.0	7.7	2.9	11.1
7. West First Street West of D Street	4,671 (5) (55)	3,200	1,750	1.7	3.1	2.4	4.5
8. West Second Street	5,329 (5) (15)	3,600	550	1.5	9.8	2.2	14.2
9. Broadway Bridge	24,069 (4) (10)	16,350	1,650	0.3	3.3	0.5	4.7
10. Broadway	14,824 (5) (11)	10,100	1,100	0.5	4.9	0.8	7.1
11. Dorchester Avenue South of A Street	24,700 (4) (5)	16,800	850	0.3	6.4	0.5	9.2
12. Southampton Street	15,852 (5) (14)	10,800	1,500	0.5	3.6	0.7	5.2

NOTES:

1. Locations of roadways shown in Figure E-7.
2. 11-Hr traffic volumes are 68% of total ADT
3. Vanasse/Hangen, 1982
4. Mass DPW, et al, 1982
5. Fay, et al, 1980

TABLE E-4

ESTIMATED 1987 RAIL TRAFFIC ON EAST AND WEST FIRST STREETS, SOUTH BOSTON

Map Location[1]	Destination	Frequency of Service, No. of Cars
1	Boston Harbor Industrial Park, various users	5 times per week, 10 to 15 cars
2	King Warehouse, American Maize Products Co	3 times per week, 3 to 5 tank cars
3	Felton & Son, Inc (Distillers)	Once every 6 months, one car
4	Boston Molasses Co	Once every 6 months, one car
5	New Boston Station[2] (ash transport)	6 times per week, 8-11 cars
6	Conley Marine Terminal at Castle Island	No estimate available

NOTES:

1. Locations are shown in Figure E-11.
2. Assumes rail transport of ash is used.

TABLE E-5

ESTIMATED 1987 VESSEL TRAFFIC IN THE RESERVED CHANNEL

Map Location(1)	Destination	Number of Trips/Week
1a	Coal Vessel - New Boston Station (proposed)	1.0
1b	Ash Transport Barges - New Boston Station (proposed)	0.9 (maximum)
2 3 4	Conley Marine Terminal Texaco (White Fuel) Sea-Land Services	2.3(2)
5	Navy Surface Action Group (under study)	Insignificant
6	Reserved Channel Marina (proposed)(3)	—

NOTES:

1. Locations are shown in Figure E-12.
2. The total traffic from these 3 facilities is 2.3 trips\week.
3. Recreational boats are not expected to have an impact on shipping in the Reserved Channel.

TABLE E-6

BOSTON HARBOR VESSEL TRAFFIC, 1980

	Inbound	Outbound
Self-propelled vessels:		
Passenger & dry cargo	4932	4914
Tankers	999	1029
Towboat or tugboat	1358	1434
Non self-propelled vessels:		
Dry cargo	52	50
Tankers	835	808
Total	8176	8235

SOURCE:

U.S. Army Corps of Engineers, Waterborne Commerce of the United States, Part I. 1980.

TABLE E-7

EMISSIONS FROM DIESEL ASH TRUCKS AND VEHICLE TRAFFIC ALONG TRUCK ROUTES

Emission Source	Emissions (lb/day) PM(1)	CO(2)	HC(3)	NOx(4)
Vehicle traffic	7.5-63	1226-10,296	119-1000	71-593
Ash trucks (Normal station load)	0.32-0.47	6.55-9.82	1.09-1.64	4.83-7.24
Ash trucks (Maximum station load)	0.44-0.66	9.17-13.75	1.53-2.29	6.76-10.13

NOTES:

1. Particulate Matter
2. Carbon Monoxide
3. Hydrocarbons
4. Nitrogen oxides

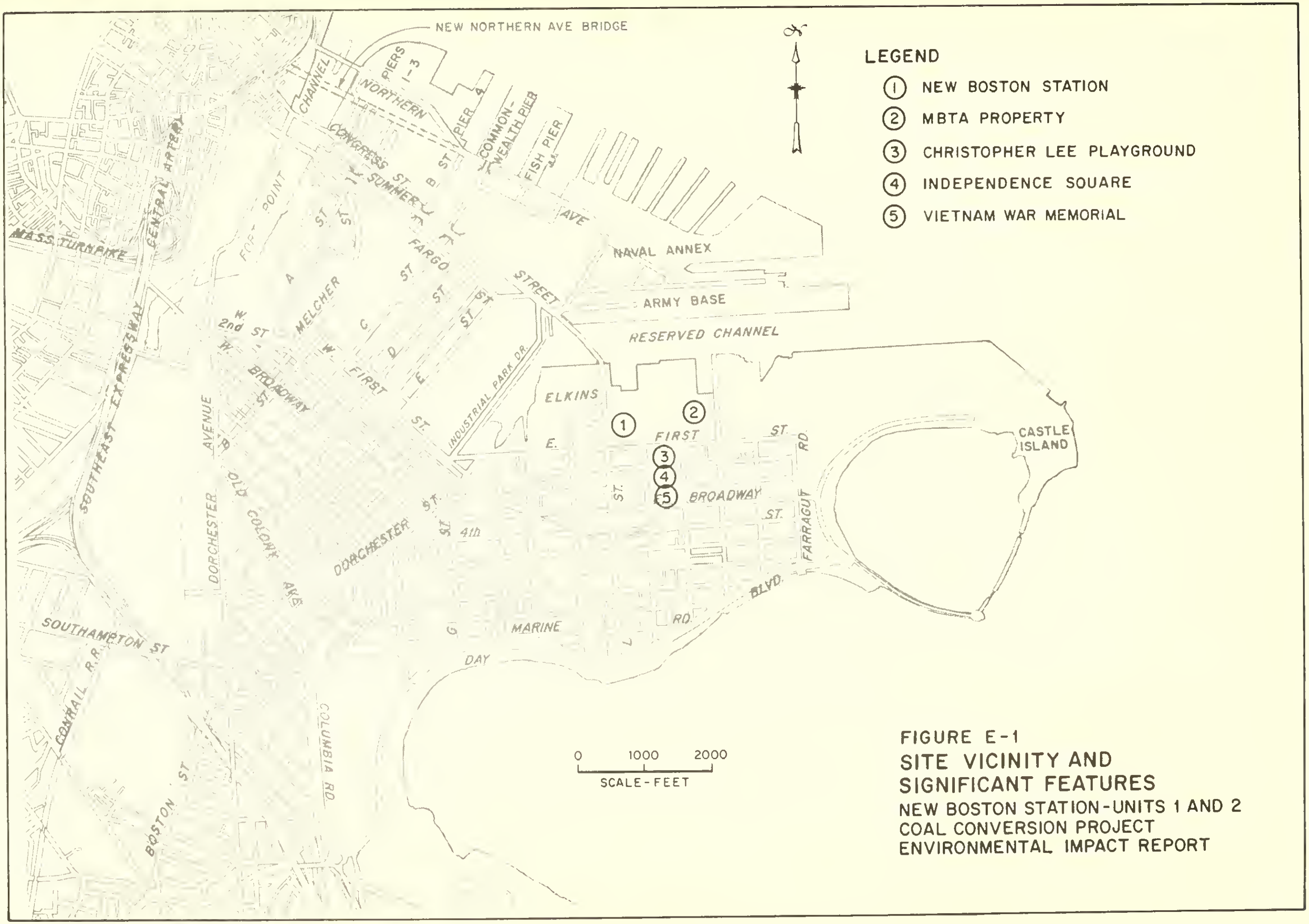


FIGURE E-1
SITE VICINITY AND
SIGNIFICANT FEATURES
NEW BOSTON STATION-UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT

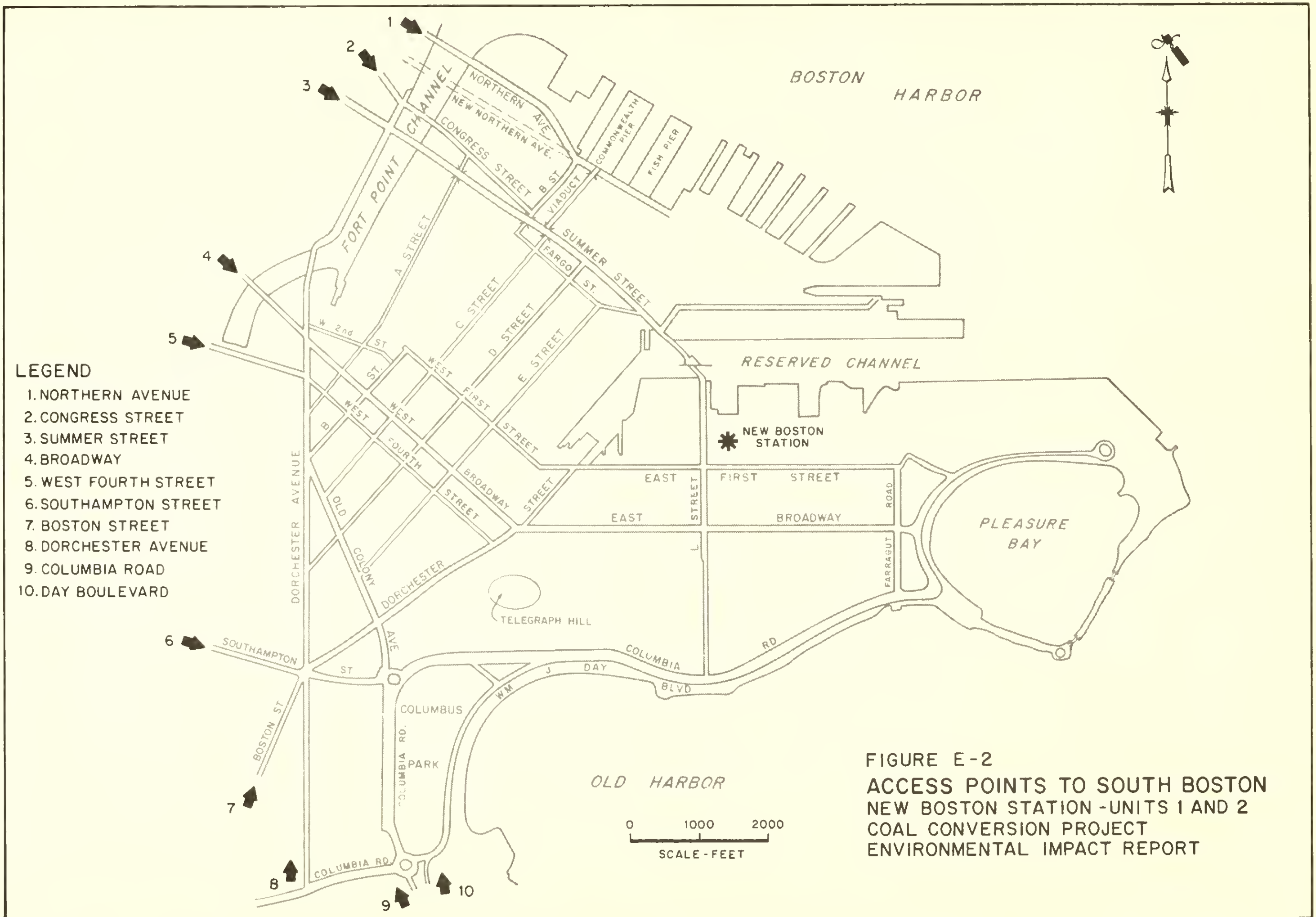


FIGURE E-2

ACCESS POINTS TO SOUTH BOSTON
NEW BOSTON STATION - UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT

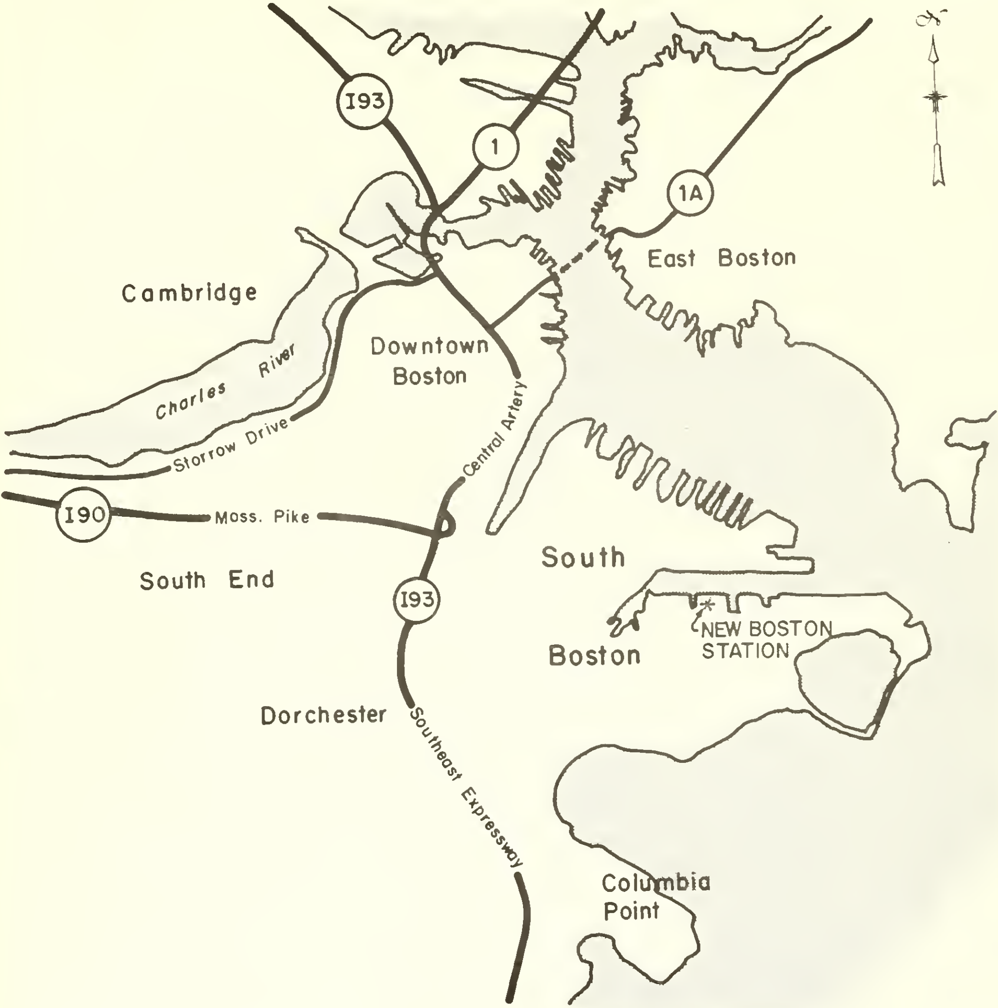
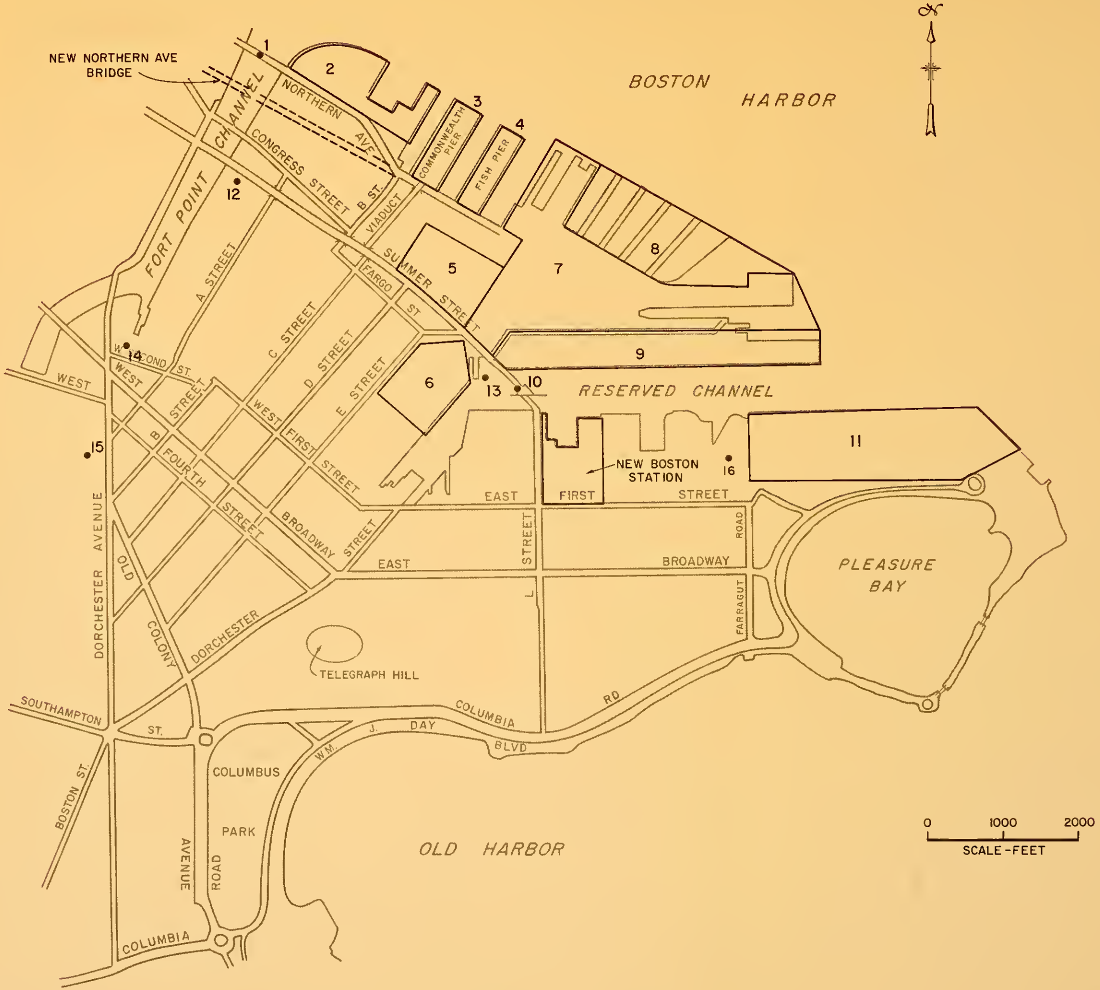


FIGURE E-3

THE REGIONAL ROAD NETWORK

NEW BOSTON STATION - UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT



LEGEND

1. NORTHERN AVENUE BRIDGE
2. ANTHONY'S PIER 4 AND FAN PIERS 1-3
3. COMMONWEALTH PIER DEVELOPMENT - BOSCOM
4. FISH PIER RENOVATION
5. COMMONWEALTH FLATS
6. U.S. NAVAL RECREATION AREA
7. BOSTON MARINE INDUSTRIAL PARK
8. BOSTON SEAPORT DEVELOPMENT
9. GARMENT INDUSTRY - U.S. ARMY RESERVATION BUILDING 114
10. SUMMER STREET BRIDGE
11. CONLEY MARINE TERMINAL AT CASTLE ISLAND
12. TOWN & CITY PROPERTIES, INC. PROJECT PROPOSAL
13. BOSTON HARBOR INDUSTRIAL DEVELOPMENT CORP. PROJECT PROPOSAL
14. GILLETTE CAPITAL INVESTMENT PLAN
15. MBTA MAINTENANCE FACILITY PROPOSAL
16. TEXACO (WHITE FUEL)

FIGURE E-4
PROPOSED AND ONGOING PROJECTS
IN SOUTH BOSTON

NEW BOSTON STATION - UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT

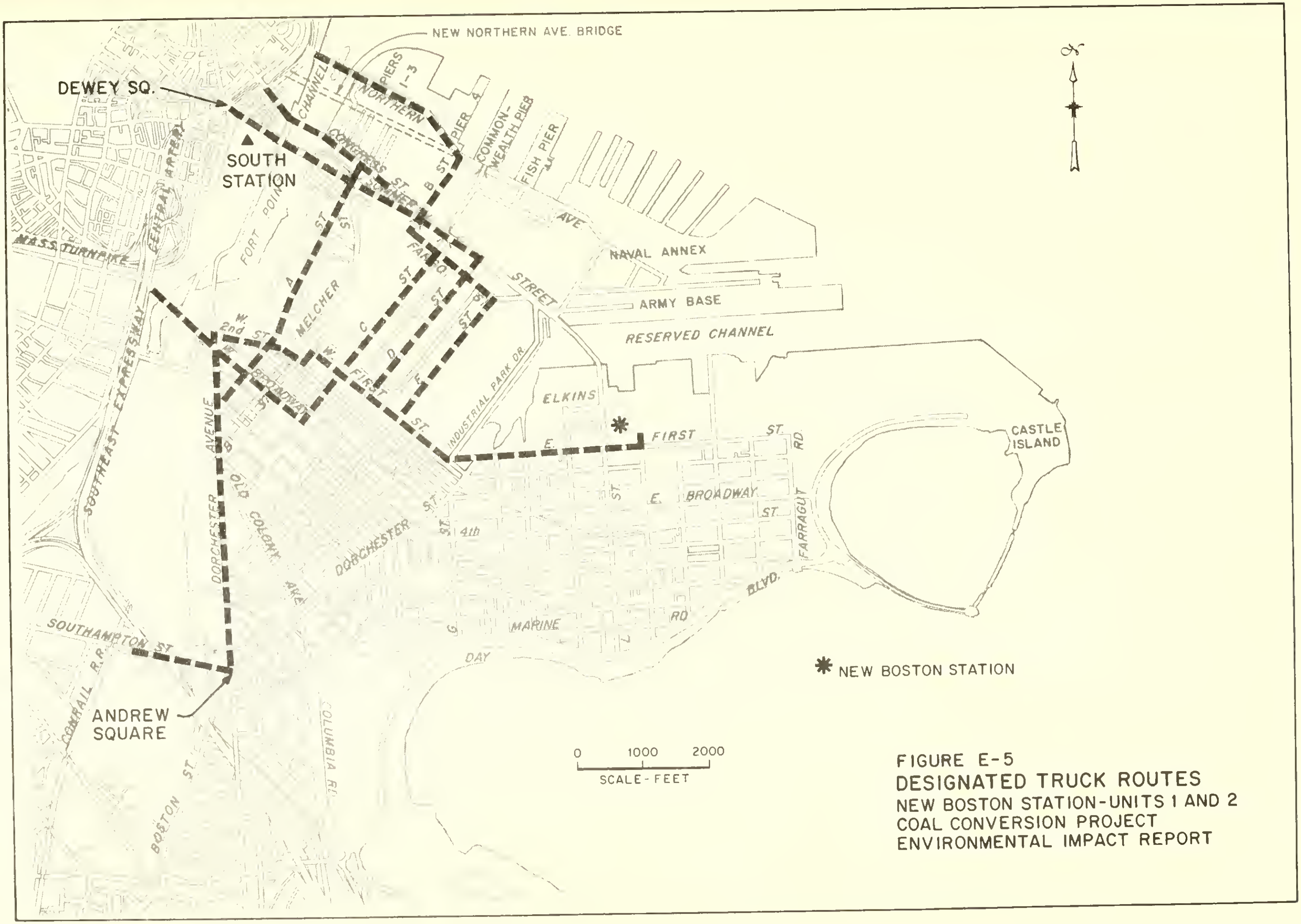


FIGURE E-5
DESIGNATED TRUCK ROUTES
NEW BOSTON STATION-UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT

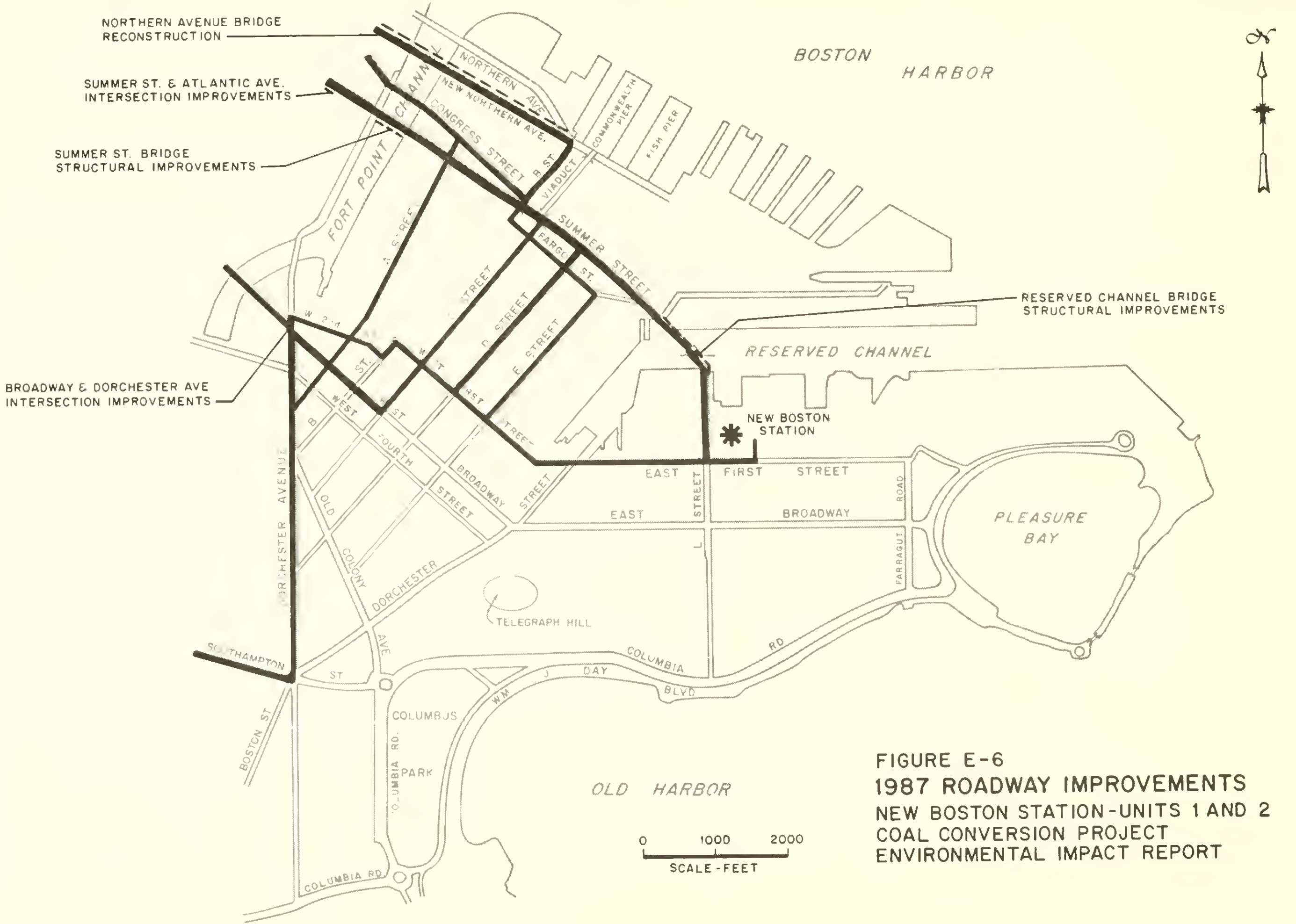


FIGURE E-6
1987 ROADWAY IMPROVEMENTS
NEW BOSTON STATION-UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT

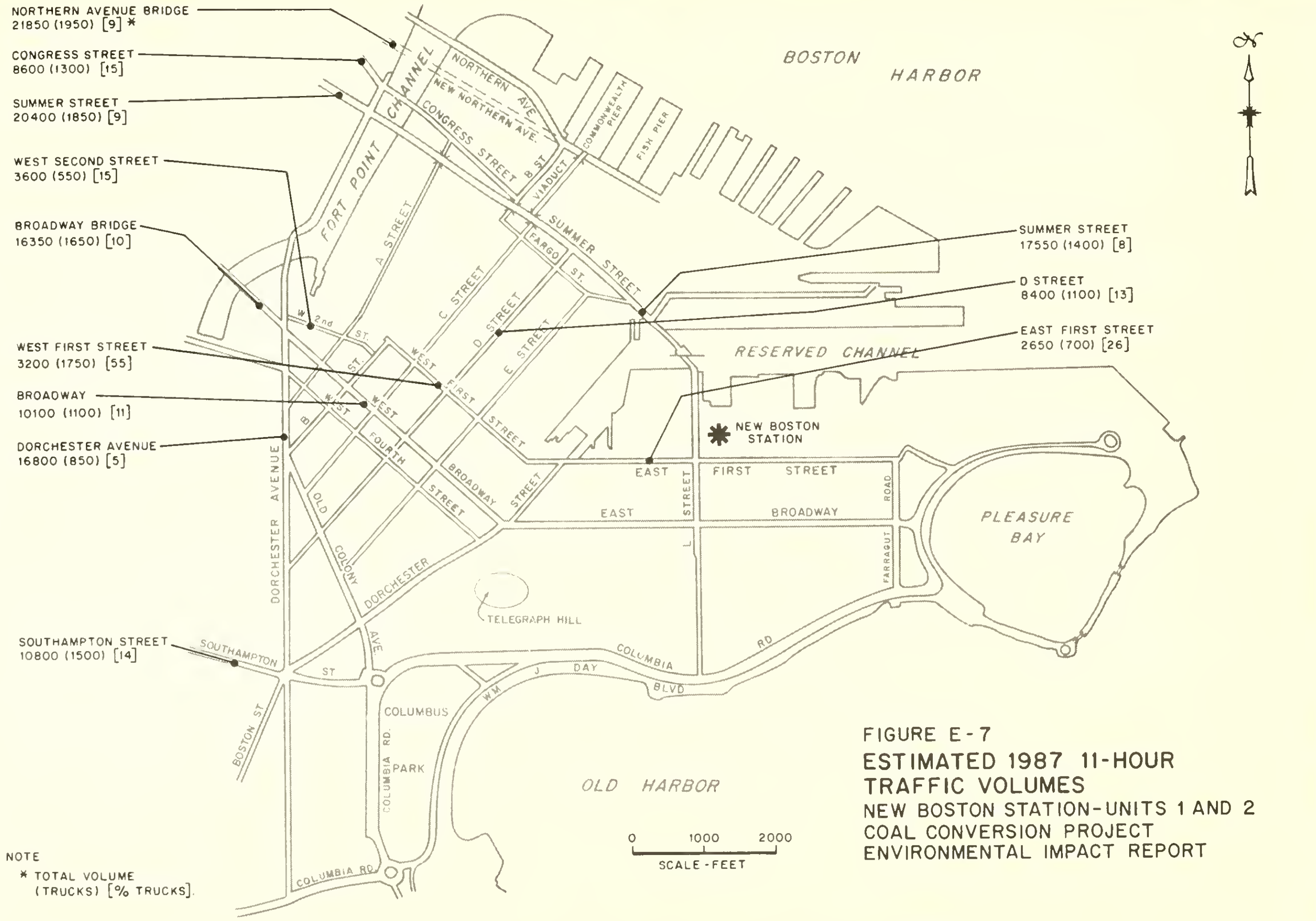
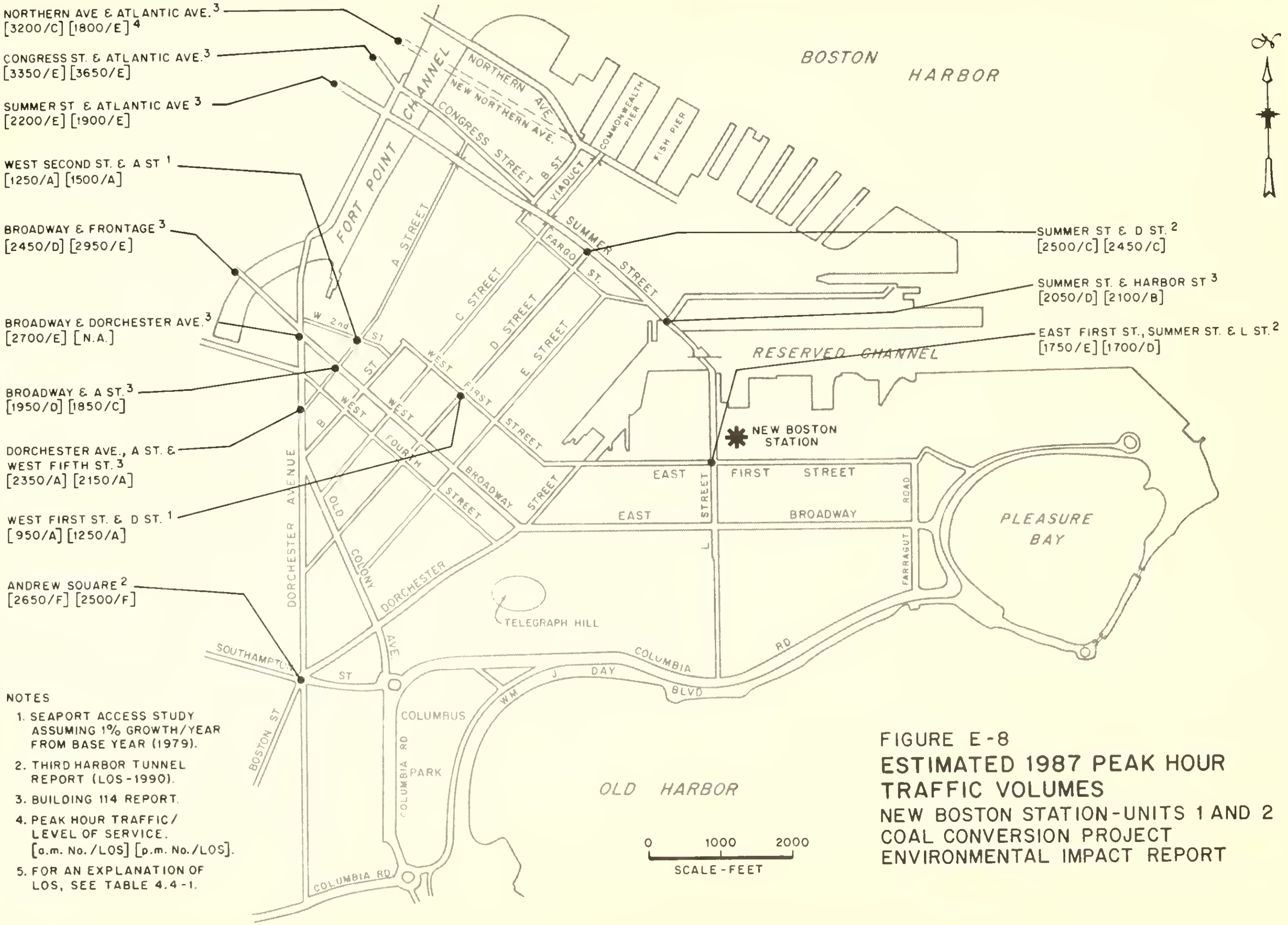


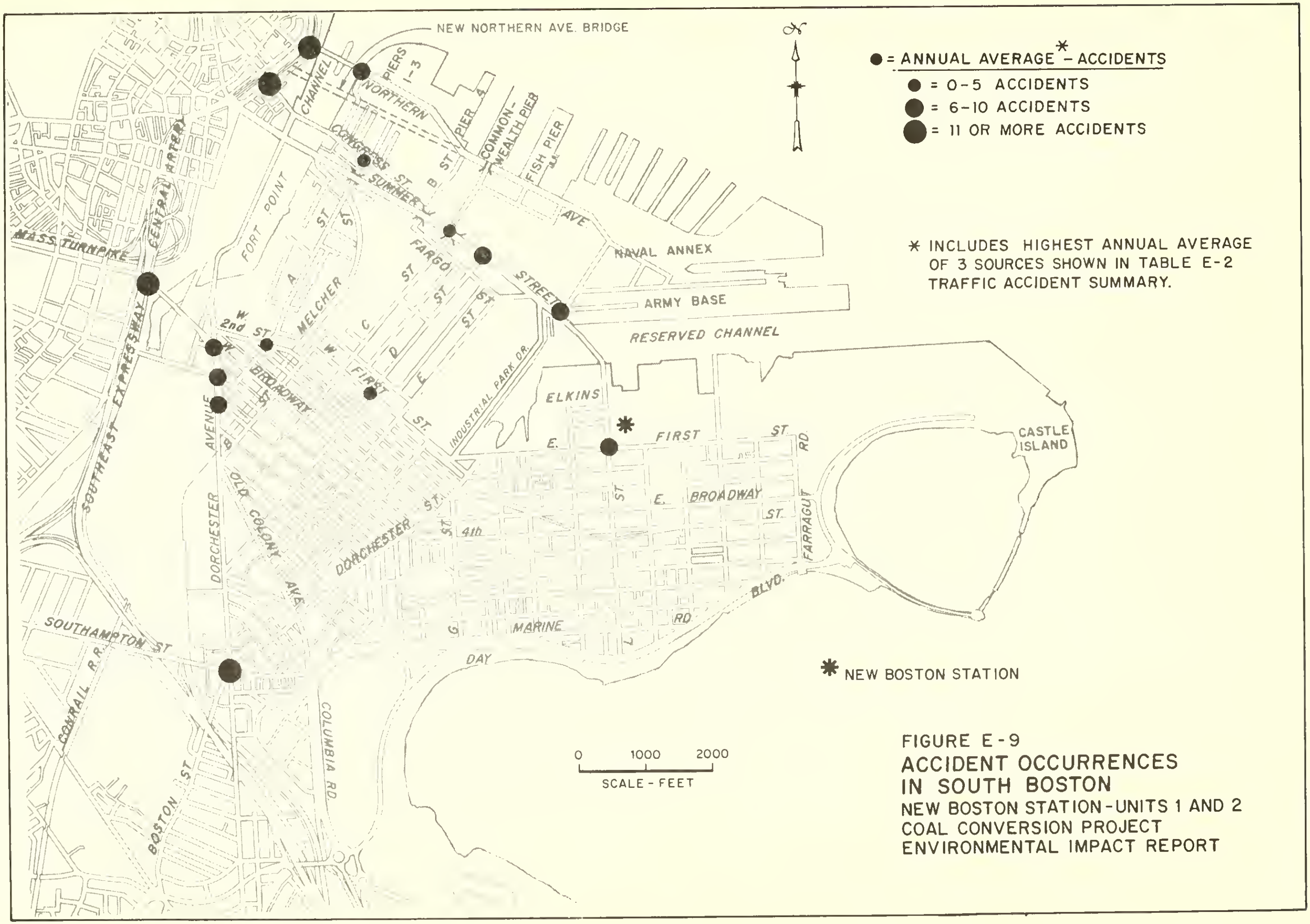
FIGURE E-7
ESTIMATED 1987 11-HOUR TRAFFIC VOLUMES
NEW BOSTON STATION-UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT


NORTHERN AVE & ATLANTIC AVE.^{3} [3200/C] [1800/E]^4
CONGRESS ST. & ATLANTIC AVE.^{3} [3350/E] [3650/E]
SUMMER ST. & ATLANTIC AVE^3 [2200/E] [1900/E]
WEST SECOND ST. & A ST^1 [1250/A] [1500/A]
BROADWAY & FRONTAGE^3 [2450/D] [2950/E]
BROADWAY & DORCHESTER AVE.^{3} [2700/E] [N.A.]
BROADWAY & A ST.^{3} [1950/D] [1850/C]
DORCHESTER AVE., A ST. & WEST FIFTH ST.^{3} [2350/A] [2150/A]
WEST FIRST ST. & D ST.^{1} [950/A] [1250/A]
ANDREW SQUARE^2 [2650/F] [2500/F]
SUMMER ST & D ST.^{2} [2500/C] [2450/C]
SUMMER ST. & HARBOR ST^3 [2050/D] [2100/B]
EAST FIRST ST., SUMMER ST. & L ST.^{2} [1750/E] [1700/D]
BOSTON HARBOR
FORT POINT CHANNEL
NORTHERN AVE.
NEW NORTHERN AVE.
CONGRESS STREET
B ST.
VIADUCT
COMMONWEALTH PIER
FISH PIER
SUMMER STREET
FARGO ST.
A STREET
C STREET
D STREET
E STREET
W 2nd ST
WEST ST
WEST FIRST STREET
WEST FOURTH STREET
WEST B
OLD COLONY AVE.
BROADWAY STREET
DORCHESTER STREET
DORCHESTER AVENUE
RESERVED CHANNEL
NEW BOSTON STATION
EAST FIRST STREET
EAST BROADWAY
L STREET
ROAD
FARRAGUT
PLEASURE BAY
TELEGRAPH HILL
COLUMBIA RD
WM J DAY BLVD
SOUTHAMPTON ST
BOSTON ST
COLUMBUS PARK
COLUMBIA RD
OLD HARBOR
0 1000 2000
SCALE-FEET

NOTES

1. SEAPORT ACCESS STUDY ASSUMING 1% GROWTH/YEAR FROM BASE YEAR (1979).
2. THIRD HARBOR TUNNEL REPORT (LOS-1990).
3. BUILDING 114 REPORT.
4. PEAK HOUR TRAFFIC/ LEVEL OF SERVICE. [a.m. No./LOS] [p.m. No./LOS].
5. FOR AN EXPLANATION OF LOS, SEE TABLE 4.4-1.

FIGURE E-8
ESTIMATED 1987 PEAK HOUR TRAFFIC VOLUMES
NEW BOSTON STATION-UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT



* INCLUDES HIGHEST ANNUAL AVERAGE OF 3 SOURCES SHOWN IN TABLE E-2 TRAFFIC ACCIDENT SUMMARY.

FIGURE E-9
ACCIDENT OCCURRENCES
IN SOUTH BOSTON
NEW BOSTON STATION-UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT

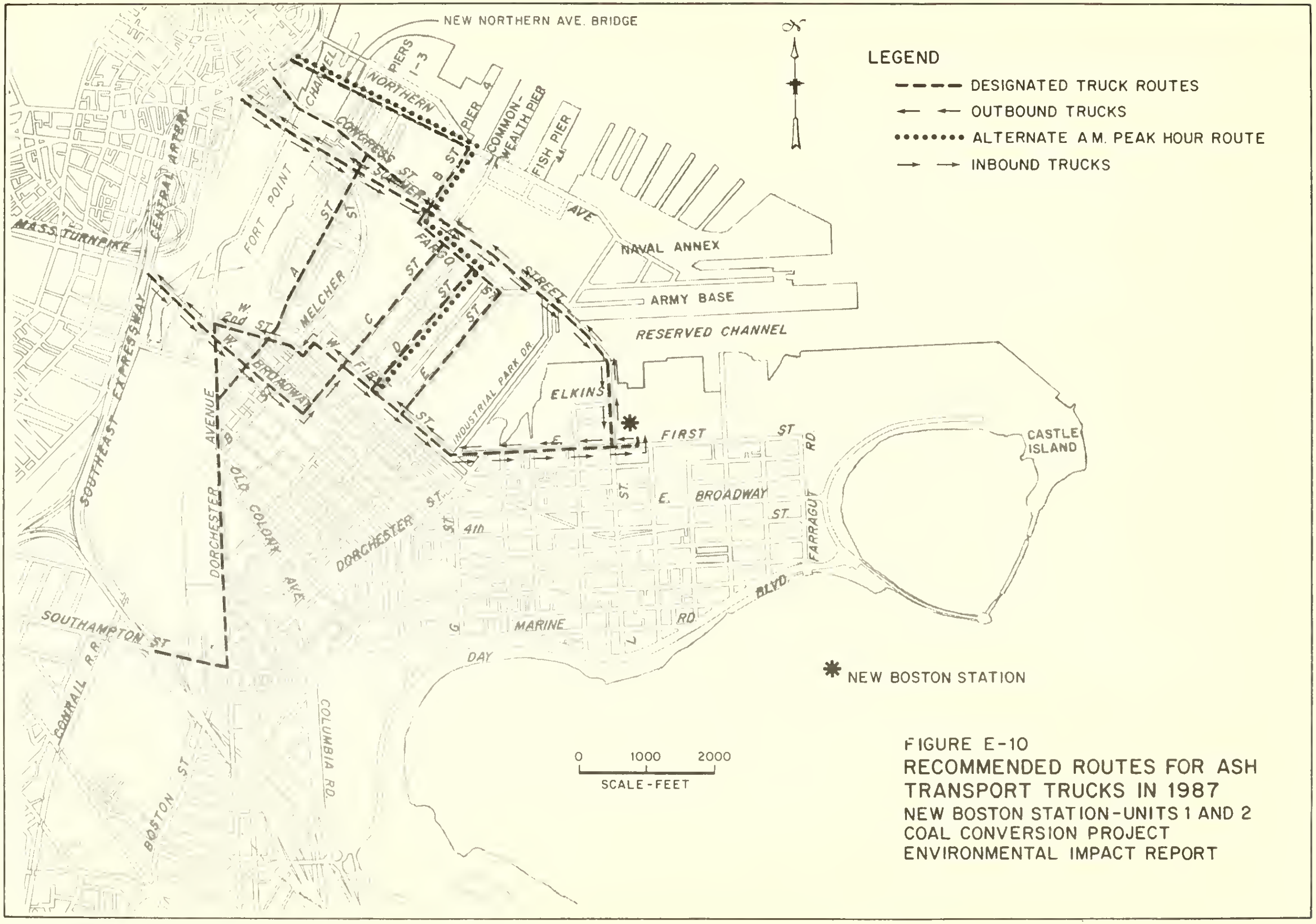


FIGURE E-10
RECOMMENDED ROUTES FOR ASH TRANSPORT TRUCKS IN 1987
NEW BOSTON STATION-UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT

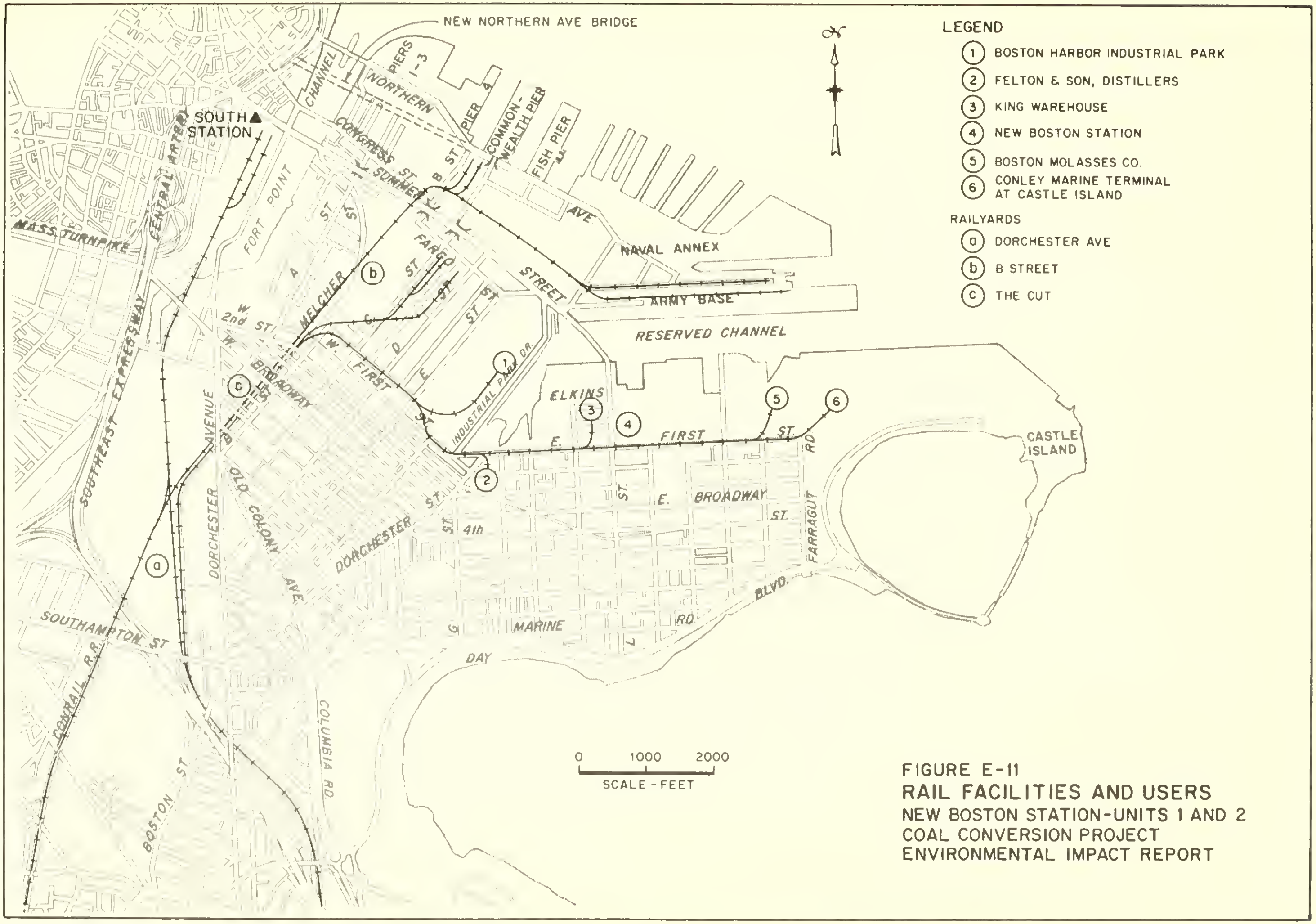


FIGURE E-11
RAIL FACILITIES AND USERS
NEW BOSTON STATION-UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT

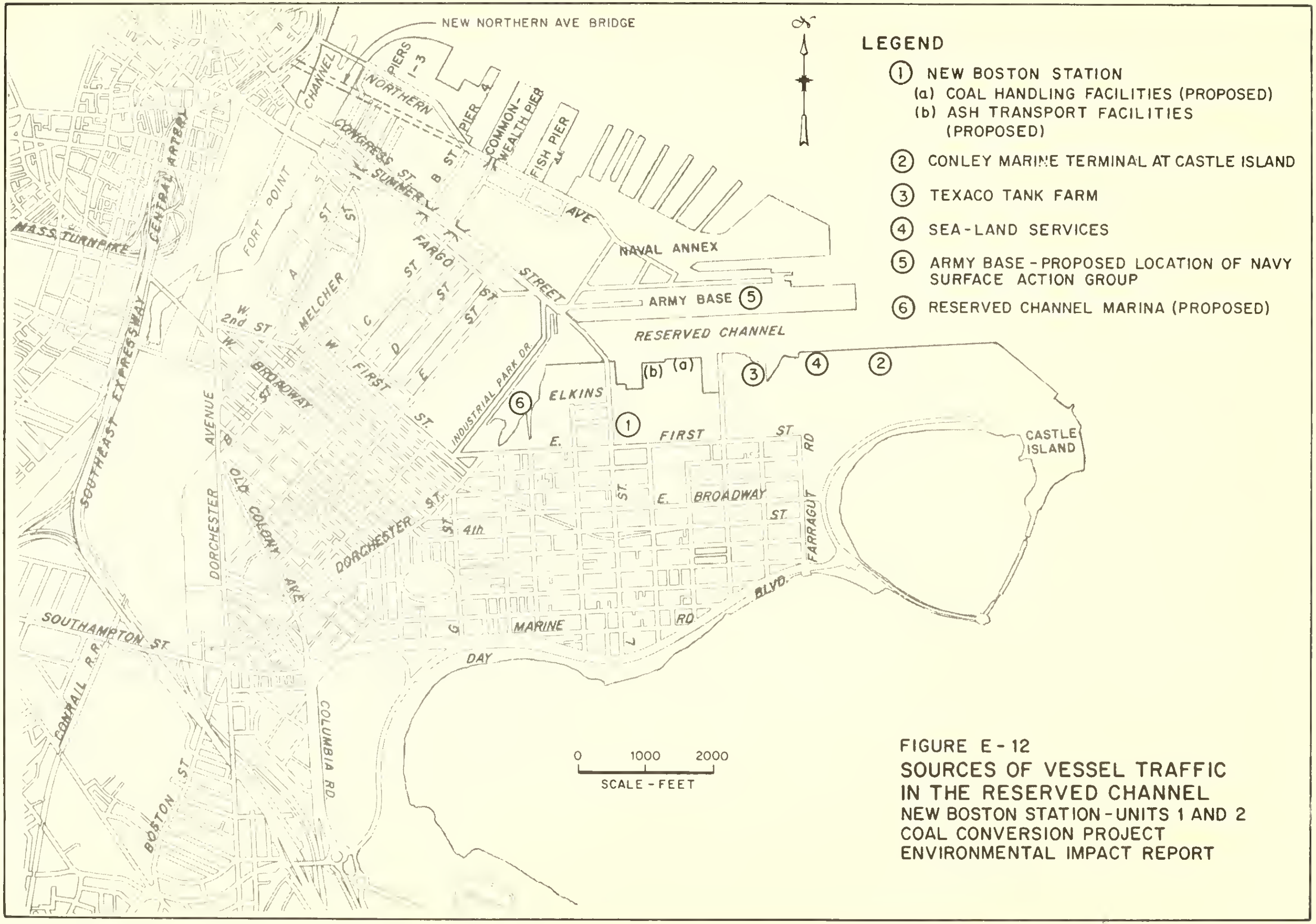


FIGURE E-12
SOURCES OF VESSEL TRAFFIC IN THE RESERVED CHANNEL
NEW BOSTON STATION - UNITS 1 AND 2
COAL CONVERSION PROJECT
ENVIRONMENTAL IMPACT REPORT

SOD46-A

APPENDIX F

INITIAL MARKET ASSESSMENT:
BOSTON EDISON
COAL ASH

Prepared by
Boston Edison Company

CONTENTS

Page

Section I: Introduction 1

Section II: Ash Background 2

- A. Quantity 2
- B. Definitions 2
- C. Ash Quality 3

Section III: Institutional Factors Affecting the Utilization of Fly Ash 5

- A. Environmental 5
  - 1. Federal 5
  - 2. State Regulation 6
- B. Domestic Standard Specifications 7
- C. Market Factors 7
  - 1. Competition in Ash Marketing
  - 2. General Acceptance of the Market

Section IV: Fly Ash Utilization 9

- A. Fly Ash 9
  - 1. Cement and Concrete
- B. Fly Ash Utilization Potential - Cement and Concrete Products in Massachusetts and New England 14
  - 1. Clinker Production and Fly Ash Use 14
  - 2. Concrete Products and Concrete 14
  - 3. Ready Mix (S.I.C. - 3273) 15
  - 4. Economics of Fly Ash Utilization in Ready Mix 16
  - 5. Concrete Block (S.I.C. - 3271) 17
  - 6. Concrete Products (Except Block) (S.I.C. - 3272) 19
  - 7. Economics of Fly Ash Use in Cement Products, Except Block 20
- C. Fly Ash Utilization - Structural Fill 22
- D. Fly Ash Utilization - Aggregate 23
- E. Fly Ash Utilization - Miscellaneous 24
- F. Summary: Fly Ash Utilization 24

Section V: Bottom Ash Utilization 26

- A. Road Base and Bituminous Concrete 26
- B. Abrasive 28
- C. Bottom Ash - Miscellaneous Use 28
- D. Summary: Bottom Ash Utilization 29

Section VI: Summary - Ash Utilization 31

TABLES

		Page
Table A:	Boston Edison: Assumed Ash Production Per Year (Tons)	2
Table B:	Possible Uses of Fly Ash/Possible Uses of Bottom Ash	10
Table C:	Cement Types in which Ash may be used	13
Table D:	Currently Accepted Levels of Fly Ash Utilization in Cement and Concrete Products	13
Table E:	Categorical End Use of Portland Cement by Percent	15
Table F:	Boston Edison: Fly Ash Market Potential Cement and Concrete Products	21
Table G:	Summary of Fly Ash Reuse Potential	25
Table H:	Summary of Bottom Ash Reuse Potential	30

BOSTON EDISON COAL ASH UTILIZATION

Section I - Introduction

The purpose of the following is to provide an overview of the potential for utilizing coal ash produced by Boston Edison.

Nationally, the utilization of coal ash by-products has increased significantly since the 1960's. However, as may be seen in Reference A, ash utilization is tempered by cyclical movements in the economy. As with any resource, the demand for ash is a derived demand. It is derived from the production of those goods and services in which ash may be used. Further, ash demand is influenced by industry perceptions and past production habits. It is very difficult to convince a producer to change his input mix when he has success in using such inputs. This is made even more difficult by the existence of rigid and well-defined standards which producers must meet. Ash is utilized mainly in the production of products which are subject to such standards. Therefore, although the purpose of this report is to stress and assess the potential for ash utilization, one should constantly keep in mind the limits to such use and the actions required to offset such limits in planning and developing a program for ash utilization and/or disposal.

Section II - Ash Background

A. Quantity

The Massachusetts State Implementation Plan (SIP) requires a maximum coal ash content of 9% (dry weight), and current policy allows a higher ash content if particulate emissions are kept below the maximum permitted. Boston Edison Company (BECo.), however, does not expect ash content, on average, to be above 9%, therefore, for the purposes of this report, 9% ash coal will be used. Based upon a 70% average annual capacity factor, the following quantity of ash can be expected:

TABLE A
Boston Edison:
Assumed
Ash Production Per Year (Tons)

	Mystic Units 4, 5 & 6	New Boston Units 1 & 2	Total
Fly ash	66,000 (80%)	122,000 (80%)	188,000
Bottom ash	16,000 (20%)	30,000 (20%)	46,000
Total	82,000	152,000	234,000

In total, BECo. will be faced with the problem of disposing of approximately 234,000 tons of ash per year, assuming the conversion of both the Mystic and New Boston Units. Each ton of ash which can be disposed of through reuse represents savings in the cost of landfill disposal.

B. Definitions

Bottom ash may be either wet or dry, depending upon boiler design.

Dry Bottom Ash

Dry bottom ash is the residue from coal burned in dry bottom boilers. It generally is a well-graded aggregate ranging in size between the 3/4 inch (19 mm) and the standard U.S. #220 sieve. It is porous and susceptible to degradation under compaction and loading. It's specific gravity ranges between 2.10 and 2.40, and its major chemical constituents are silica, ferric oxide and alumina.

Wet Bottom Ash

Wet bottom ash is produced when the molten residue or slag in a wet bottom boiler is discharged into a water-filled hopper. It is smaller in maximum size than dry bottom ash and the particles are glassy, very hard and brittle. The specific gravity is usually around 2.7, but increases as the iron content increases.

Fly ash

Fly ash is the material collected in the precipitators that remove particulate matter from the exhaust gases of the power plant. Generally finer than portland cement, fly ash consists mostly of small spheres of glassy compounds of complex combinations of silica, ferric oxide and alumina.

C. Ash Quality

The potential for utilization of ash as a resource is directly dependent upon its chemical characteristics. The chemical characteristics of ash are dependent upon the type of coal purchased, the pulverization process, the design and control of boilers and type and quality of ash collection handling and storage equipment. It has been determined that generalizations cannot be made relative to the quality and composition of ash even if one knows each of the factors noted above.[1] The same coal type, with similar pulverization, boiler design and ash handling may produce a different quality of ash depending upon boiler control and loading characteristics of a production unit. It is for this reason that coal ash quality must be measured on a daily basis. (Note: There are arguments concerning the effect of loading on ash quality. Fundamentally, this will have to be determined through experience.)

BECo. is in the planning stages for the conversion of Mystic and New Boston stations to coal, therefore a specific coal source has not been identified. However, the units under consideration were designed originally for the use of high grade Eastern bituminous coal.

Fly ash (which is expected to make up 80% of the ash produced by volume by BECo.)which results from the use of bituminous coal has no selfhardening or setting properties but has pozzolanic properties. This means that in the presence of water the fly ash particles react with calcium hydroxide (lime) to form cementitious products. The cementitious products are chemically similar to those found in hydrated Portland Cement.

The hardening properties of fly ash are dependent upon the amount of calcium present in the ash and the manner in which it is combined with other elements. Total calcium, expressed as calcium oxide, has been found to range between 1% and 12% in ash from bituminous coals. The median value is in the 5% to 8% range. A general statement as to how the calcium is combined in particular ash cannot be made. It may be present as calcium oxide (free lime), or it may be combined with silica and alumina as part of the glassy components.

---

[1] Discussion with R. Morrison, American Electric Power, Ash Management and Past President, National Ash Association. January 11, 1983.

The fly ash from bituminous coal is often referred to as a "low lime fly ash" versus the "high lime ash" coming from sub-bituminous coal or lignite. There are differences in how the calcium is combined and one cannot simply add more lime to "low-lime" bituminous derived fly ash and obtain the same properties provided by high lime ash. This is of importance when assessing the potential use of fly ash. Although much of the recent literature available on ash utilization has addressed the use of "low-lime ash", particular applications may not be appropriate due to the chemical properties of the ash. Each source of ash needs to be tested for suitability for each specific application. Therefore, given the lack of specific chemical composition of BECo.'s ash until it is produced, potential ash utilization can only be assessed from a generic perspective.

Section III - Institutional Factors Affecting The Utilization of Ash

A. Environmental

1. Federal

The Resource Conservation and Recovery Act (RCRA) governs the federal regulation of solid waste. Fly ash, bottom ash, slag and flue gas emission control wastes produced from coal or fossil fuel combustion have not been designated as a hazardous waste.

Under RCRA, federal involvement in non-hazardous waste disposal is limited with actual regulation in the hands of the state. However, in Section 6002 (E) of RCRA the federal procurement of fly ash and cement and concrete is discussed. This section of the act "directs all procuring agencies utilizing federal government funds to procure items containing the highest percentage of recovered materials practicable, given reasonable levels of competition, cost, availability and technical performance". The final guidelines implementing the requirements of Section 6002 (E), which strongly advocate the use of ash in cement and concrete, and the growing awareness and acceptance of coal ash for engineering applications can only enhance acceptability of coal ash as a resource.[2]

In addition, in 1974 the Federal Highway Administration, which works closely with the American Association of State, Highway and Transportation Officials (AASHTO) to develop national standards for road construction, issued a memorandum to state highway officials. The memo (N 5080.4) indicated that approximately 10% to 15% of the cement used in road construction could be substituted for by fly ash without sacrificing strength requirements. In addition, the Army Corps of Engineers has made significant use of fly ash in its construction activities. Therefore, there are at this point in time, very few constraints imposed on the potential utilization of coal ash from federal regulations. Rather, the federal government through either the Department of Transportation or the Corps of Engineers or the EPA has been stimulating the use of ash for select purposes.

2. State Regulation

On May 20, 1976 House Bill 4596, which amended Section 150A of Chapter 111 of the General Laws was passed by the legislature.[3] This made Massachusetts the second state to enact legislation designating ash as a resource and provided a simplification in licensing requirements for the storage of ash. Although the law exempts the use of coal ash as a raw material for industrial or commercial purposes from DEQE approval requirements and local site requirements (Board of Health approvals), it does not mean that each specific use will not be subject to some type of environmental probe.

---

[2] Reference C EPA Guidelines applicable to Section 6002(E) of RCRA.

[3] See Reference D.

B. Domestic Standard Specifications

Various organizations establish standards related to the use of specific inputs and/or products. Although national standards have been developed for many uses of fly ash and bottom ash, for select purposes, state specifications may differ.

The American Society For Testing And Material (ASTM) is the major national organization for most engineering related materials standards. Other nationally recognized standard setting organizations include: The American Concrete Institute (ACI), The U.S. Army Corp of Engineers, and the American Association of State, Highway and Transportation Officials (AASHTO).[4] Those standards applicable to a particular product will be indicated in each section assessing usage by product line.

C. Market Factors

1. Competition In Ash Marketing

The growing awareness of the potential for ash usage in diverse applications is being accompanied by growing ash production in Massachusetts. There is no doubt that each utility must create its own market for ash. Although transportation costs limit the geographic depth of the market for a particular utility, utilities in Massachusetts are relatively close in proximity. Therefore, as one utility develops a market for its product it can be assumed that market potential will expand.

2. General Acceptance of the Market

Engineers and architects generally believe fly ash to be an inferior substitute product for traditionally used material inputs. As part of its general education efforts, the National Ash Association (NAA) is slowly reversing this belief. However, as indicated previously, habits are difficult to adjust. In a full marketing effort, Boston Edison would be required to use every effort to educate potential users to the value as well as limits to the use of ash. As standards continue to evolve and federal and state support continues, the barriers to the use of ash, erected by past habits, can be eliminated. The first step in this effort would be for Boston Edison to begin immediately requesting that, if possible, ash be used in projects which it is undertaking. This step would enhance the development of the market for ash for other utilities in New England but would also begin to open a market for the Boston Edison Company (BECo.) when it starts producing ash. It is this type of support which is required if past habits and beliefs are to be dissipated. According to NAA, 1980 data, nineteen (19) percent of all ash utilized was used internally, i.e. by ash producers.

---

4. Reference B contains a listing of various standards impacting potential coal ash utilization.

Section IV - Fly Ash Utilization

Table B below provides a listing of twenty-five (25) potential uses for fly ash and six (6) potential uses for bottom ash. The purpose of the following is to provide an analysis of the market for fly ash produced by Boston Edison within significant potential use categories.

A. Fly Ash

According to the National Ash Association (NAA) statistics provided in Reference A, 18.7 percent (12.4 million tons) of total ash produced in 1980 was reused for various purposes. Although only 13.3 percent (6.42 million tons) of total fly ash produced was utilized, fly ash reuse accounted for 52 percent of all ash utilized. Boston Edison is expected to burn bituminous coal. Combustion of bituminous coal produces what has been classified (ASTM) as Type F ash[5]. Type F ash has pozzolanic properties but is not self hardening. Most research into potential utilization of ash has been directed to the reuse of Type F ash.

The greatest use of fly ash currently is as a substitute for other material inputs utilized in construction activities. These materials include, but are not limited to, portland cement, aggregate, structural fill and road-base material.

The greater the native supply of resources for which fly ash may substitute (which is reflected in relative price) the greater the difficulty in getting ash accepted as a substitute. Therefore, an understanding of factors affecting current supply must be achieved to gain some insight into the potential marketability of fly ash.

1. Cement and Concrete

Cement is a mineral product. It is produced by grinding a carefully proportioned mix of materials such as limestone, silica, iron ore, sand and clay. The mixture is then heated in rotary kilns at approximately 2700°F to form cement clinkers. The clinker is then ground with a small amount of gypsum to produce a fine powder-portland cement. Portland cement is a generic term indicating an inorganic hydraulic cement (a cement which will combine with water and harden).

Cement is mixed with various aggregates, e.g., sand, gravel, crushed stone, to form concrete. Cement is used as an input in construction but not a final product, the final product is concrete.

Basically, fly ash may be utilized in three ways in the production of cement and concrete.

---

[5] Reference F contains applicable ASTM Specification C618-80.

TABLE B

POSSIBLE USES OF FLY ASH

1. As a replacement for cement in concrete
2. As a raw material in brick manufacture
3. As a cement replacement in the manufacture of precast concrete products
4. As a raw material ingredient in the manufacture of Portland Cement
5. As an ingredient in the manufacture of roofing felt
6. As a raw material for making mineral wool insulation
7. As an aggregate for the stabilization of highway subgrades
8. As an aggregate for road base material
9. As a controlled density fill for backfill of various construction
10. As a raw material for metal reclamation
11. For fighting mine fires and controlling subsidence
12. In the amelioration of soils
13. As a mineral filler in asphaltic concrete
14. As a source of cenospheres
15. As an ingredient in grouting
16. As a material for absorbing oil spills
17. As a medium for filtering insulating oil used by utilities
18. As an absorbent for dewatering sewage sludge
19. As a fixation ingredient for sulfate sludge
20. As a raw material in the manufacture of lightweight aggregates
21. As a flowability agent in molding sand
22. As a filler material in plastics
23. As a sanitary landfill cover
24. As an ingredient in aerated concrete
25. As a material for structural fill

POSSIBLE USES OF BOTTOM ASH

1. As an aggregate in cold mix asphalt
2. As an ingredient in bituminous stabilized bases for highways
3. As an aggregate in Portland Cement stabilized bases for highways
4. As a grit for ice covered roads
5. As a filter material
6. As a structural fill

- Cement Production

  Fly ash may be used to replace raw materials utilized in forming the mixture to produce clinkers. In the chemical reaction which occurs in the process of cement clinker production the fly ash loses its identity. Therefore, cement produced in this way is usually not identified as containing fly ash. ASTM C-150, the standard specification for portland cement allows for the use of fly ash in the manner indicated above. It should be recognized that this type of usage of fly ash is highly dependent upon the characteristics of the cement plant and the need and availability of particular raw materials.

- Blended - Cement

  Fly ash may be blended with portland cement to produce what is referred to as Type I (P) or Type I (PM) cement. As a blend, fly ash cement meets ASTM specification C595.

- Replacement of Cement In Concrete

  In making concrete, fly ash may be utilized as an admixture replacing part of the cement. When used as an admixture in concrete flyash must meet ASTM specification C311, while the concrete product must meet ASTM specification C-618.

There are both positive and negative results from utilizing fly ash in cement and concrete. These are:[6]

- Positive Effects

  a. Improved workability
  b. Reduced segregation
  d. Reduced heat of hydration
  f. Increased resistance to sulfates
  g. Increased ultimate tensile and compressive strength
  h. Reduced permeability

- Negative Effects

  a. Lower early strength (Disputed)
  b. Lower freeze - thaw durability in non air-entrainment concrete
  c. Requires increased dosage of air entraining admixture

---

[6] See Reference E(1) for a complete assessment of each of these effects. Technical Report CR-79-2 Properties and Use of Fly Ash in Portland Cement Concrete. References E(2) through E(6) are used generally throughout Section IV.

These effects have been researched for Type F fly ash for many years. However, there is still dispute as to select effects.

In addition to the factors noted above, which limit as well as enhance the potential marketability of fly ash, the following factors should also be recognized:

1. It is expected that suppliers of coal fly ash will be required to certify the physical and chemical characteristics of fly ash which they supply. This expected requirement will result in an implied liability by the supplier thereby requiring increased quality control procedures.

2. In select cases, manufactuers of blended fly ash cement (Type I (P) and I (PM)) recommend that the product not be used at temperatures less than 50°F without close supervision. The average temperature in the greater Boston area is less than 50°F for approximately 45 percent (164 days) of the year. Although all concrete usage and required admixture ingredients change with the weather and the particular application being considered, the average temperature in New England and Boston may impose a seasonal character to the potential for marketing ash for use in blended cement.

3. The utilization of fly ash which does not meet ASTM specification C311 has been used successfully in making concrete. The fly ash quality control problem imposes costs which require additional assessment relative to the benefits of reuse. If further experimentation and testing, which is constantly occurring, finds that "non spec" fly ash can be utilized it may increase marketability while reducing cost.

4. Electrostatic precipitators produce fly ash which satisfies ASTM specification C311. The reason for this is the fact that the two most important factors affecting ash reuse are carbon content and fineness (see Appendix B). Precipitators produce a fine fly ash consistently. Also, the portion of solid spheres versus hollow spheres (cenospheres) is high in ash produced by electrostatic precipitators. Cenospheres reduce the quality of concrete produced utilizing fly ash. Although cenospheres have a higher market value than ash solids, for limited uses, cenosphere separation currently requires foregoing fly ash utilization in concrete. Cenospheres normally account for five (5) percent of fly ash produced, by weight, and twenty (20) percent by volume.

According to current research fly ash may be utilized in the four cements listed in Table C.

TABLE C
CEMENT TYPES IN WHICH ASH MAY BE UTILIZED

ASTM SPECIFICATION	PURPOSE
Type I	General Purpose Cement
Type II	Moderate sulfate resistance and heat of hydration
Type IV	Low heat of hydration
Type V	High sulfate resistance

The quantity of fly ash which may be utilized is dependent upon a number of factors. Some of these have been previously indicated, however to restate, these include:

1. Type of cement used
2. Project specifications
3. Relative Costs
4. Construction practices
5. Climate conditions
6. Required setting time
7. Strength requirements

Table D provides a summary of the percentage rate of substitution of fly ash for cement in various and concrete cement products.

TABLE D
CURRENTLY ACCEPTED LEVELS OF FLY ASH UTILIZATION IN CEMENT AND CONCRETE PRODUCTS

Product	Fly Ash Replacement Rate
Blended Cement (Type I (P)&(PM))	20%
Concrete - General construction use	15 - 50% (20%)
Concrete Block	20 - 50%
Concrete Pipe	25%
Concrete Products (Burial Vaults, Septic Tanks, etc.)	20%
Concrete (Highway)	10 - 15%

Within the following analysis estimates of potential usage are required. These estimates will be based upon minimum percentages indicated above in order to maintain a conservative re-use perspective.

B. Fly Ash Utilization Potential - Cement and Concrete Products in Massachusetts and New England.

The New England states import approximately 1.7 million short tons of cement annually. Massachusetts imports approximately 58 percent of this total, or 980,000 short tons of cement annually.[7]

The only cement manufacturing plant in New England is located in Thomason, Maine. Until February, 1983 the Maine plant was owned and operated by Martin Marietta Cement. In March, 1983 the Ciambro Construction Company of Pittsfield, Maine acquired the plant and will continue its operation. The plant, whch has a rated annual production capacity of 450,000 tons of portland cement, has produced on average, 270,000 tons annually. Coal ash is currently utilized in the manufacture of cement clinkers at the plant. The ash is produced by the plant through its coal fired kilns. The plant has not historically produced fly ash blended cement. However, within the negotiation discussions the potential for producing Type I(P) and Type I(PM) blended fly ash cement has been raised.[8]

As indicated previously, fly ash can be utilized in Type I, II, IV and V cement. Of total cement shipped in the United States, in 1980 and 1981, ninety (90) percent was of Type I and II. Sub-regional data on shipments and prices is limited. However, based on available national averages the cost of shipping cement approximates eighteen (18) percent of the mill value. Obviously, transport costs depend upon the competition which exists among various transport modes. Most cement is transported by truck, however barge and trains are used, if price competitive.

Approximately seventy-five (75) percent of all cement used in New England and one-hundred (100) percent of all cement used in Massachusetts is imported. New York and Canada are the major supply centers for New England cement. New York has five cement plants which collectively hold the largest market share in supplying cement to New England.

1. Clinker Production and Fly Ash Use

Based upon discussions with plant managers it appears highly unlikely that the Boston Edison Company (BECo.) could expect to market fly ash for cement clinker production in New York. However, the Maine plant does provide a potential for fly ash utilization in cement clinker production. How much of a potential remains indeterminate until final sale of the plant occurs and production plans are more fully developed by the new owners.

2. Concrete Products and Concrete

Due to a lack of data, one must utilize national averages to determine regional and state end use of portland cement imports. Table E below indicates, by general category of end use, the average percent of portland cement utilized for varying purposes.

---

[7] U.S. Bureau of Mines, Minerals Handbook Pre-Print, 1981.

[8] Discussions with Plant Manager by J. Whippen, BECo., January 10-12, 1983.

TABLE E
CATEGORICAL END USE OF PORTLAND CEMENT[9]
BY PERCENT

Building Materials	Concrete Products	Ready Mix	Highway Construction	Federal, State Local	Other Contractors
6.7	13.0	68.0	4.4	.5	5.9

3. Ready-Mix (S.I.C. 3273)

The largest utilization of cement is found in the production of ready-mix concrete. Based upon national averages, 667,000 tons (68 percent) of the cement imported into Massachusetts is utilized to produce ready-mix cement.

There are 37 ready-mix concrete firms in Massachusetts.[10] A sample of these firms were surveyed by telephone to determine current positions and perspectives on the utilization of fly ash in cement. The sample response consisted of the eight (8) largest suppliers of ready-mix concrete in Massachusetts. Select comments concerning the use of fly ash provide an indication of the current state of the market. For example:[11]

> "Greatest problem in use is consistency in quality...it's a real problem that reduces usage." (Note: All respondents made this or a like statement).
>
> "We have to ship it in from New Jersey...transportation costs are higher than (fly ash) product cost. If you guys (SIC) do produce a good quality ash let us know."
>
> "No we don't use it and don't know much about it."
>
> "If you have it available, price it on a two tier basis, F.O.B. (Freight-on-Board) plant and delivered - We do have cement haulers that can pick it up."
>
> "Storage costs stopped us from using it. (fly ash)."
>
> "No, we don't use it. But were experimenting now."

---

9. U.S. Bureau of Mines Mineral Yearbook - Preprint of 1981 Edition-Cement.
10. Massachusetts Directory of Manufacturers, 1981-1982 Commerce Register, Inc., 1982.
11. Comments from discussions with J. Whippen, BECo. Jan.-March 1983.

The most surprising statement came from a readi-mix company which specializes in cement pumping.

> "If the ash meets ACI-ASTM specs. we will take all you can produce."

When it was noted that BECo. would produce over 230,000 tons per year the respondent noted that the quantity:

> "Would be a drop in the bucket given what we perceive for potential use." (This statement was repeated by one other respondent.)

As can be seen, there are basically four generic responses to fly ash use in ready-mix concrete.

1. Quality control (as has been indicated previously) is of major importance if fly ash is to be marketed.

2. The market must be created. In many respects the potential market is, to an extent, ignorant of the benefits and potential savings inherent in fly ash use as a cement substitute. Many of the companies contacted would not discuss use because of a lack of knowledge.

3. Investment is required of both the fly ash producer, in storage and quality control, and the fly ash user.

4. Those companies currently utilizing fly ash are highly interested in local availability - buying direct from plant on an F.O.B. basis.

As indicated in Table D above, at a minimum, twenty (20) percent of the cement utilized for ready mix concrete can be replaced with fly ash. Given the estimate of current usage of readi-mix in Massachusetts, readi-mix manufacturers could potentially utilize 133,000 tons of fly ash per year. This is a minimum given the fact that two producers indicated strong willingness to take "all the ASTM spec. fly ash you can produce."

The acceptability of this estimate of use is reinforced by the quantity of fly ash currently utilized in Massachusetts. Three of the respondents to the telephone survey currently utilize, in total, 20,000 tons of fly ash per year. Although these three purchase the fly ash through a broker, each indicated a strong desire to be able to pick up the ash themselves at the plant, i.e., eliminate the broker. The traffic control and potential environmental control and design problems that would be presented in allowing various companies to come to the plant to pick up ash must be considered. However, in so doing one should keep in mind the requirement that to "create the market" implies "please the market."

4. Economics of Fly Ash Utilization in Ready-Mix

The final price of cement to a concrete manufacturer varies by type of cement and transportation costs from source. The price range also fluctuates with market demand. However, the price range has, for 1980-1982, fluctuated around \$50 - \$52 per ton (mill value) on average. As noted above, transport costs average approximately 18 percent of mill value for 20 major U.S. cities.[12] This would indicate a minimum delivered price of \$61.36 per ton for cement in Massachusetts. Fly ash currently utilized in Massachusetts ranges in costs from \$11 to \$12 per ton, delivered. The incentive to a ready-mix producer to replace cement with fly ash is obvious.

Utilizing 1982 dollars, BECo. could sell its fly ash (assuming quality control) for a minimum of \$7 per ton, F.O.B. plant. The \$7 was derived by subtracting an estimated transport cost of \$4.15/ton. This esimate was derived from Boston Edison studies on the average cost of transporting fly ash to disposal sites.

Assuming 133,000 tons of fly ash can be marketed, an assumption which does not appear heroic given the telephone survey response, BECo. could earn a gross revenue of \$931,000 from the sale of fly ash to ready mix producers. In addition, BECo. would save approximately \$550,000 in transport costs in not having to transport this ash to disposal sites. In total, assuming proper quality control, fly ash marketed to ready mix companies represents an annual combined gross revenue and savings potential of \$1.48 million. Again, this is a conservative estimate based upon the results of the market telephone survey. Further, since the purpose of this analysis is to determine market potential a complete financial analysis will not be accomplished.

There is an additional benefit to the Commonwealth if the indicated quantity of fly ash can be utilized. Currently all portland cement is imported. If 133,000 tons of imported cement and fly ash are replaced by fly ash produced within the state, it would eliminate an outflow of over eight (8) million dollars from the state's economy. Given an internal multiplier of approximately 4, this represents a positive addition of thirty-two (32) million dollars to the state's economic activity, which currently is lost given the need to import all Portland Cement.

5. Concrete Block. (S.I.C. 3271)

As indicated in Table D above, twenty (20) to fifty (50) percent of the cement utilized in manufacturing cement blocks can potentially be replaced with fly ash. Of the 980,000 tons of cement imported into Massachusetts, approximately 117,600 tons are utilized to manufacture concrete products.

---

[12] Minerals Yearbook - Cement-1981.

There are approximately nineteen (19) manufacturers of concrete block and brick in Massachusetts. Sixteen of these are small operations employing less than twenty (20) people. The largest block manufacturer employs 35 people, and is located in Waltham, Massachusetts. Therefore, block manufacturers in Massachusetts are small businesses with little or no research and development activity.

Utilizing a telephone survey, one-half of all known concrete block manufacturers were contacted. Many of those contacted were not willing to discuss production capability or ash utilization. However, the largest companies, which have a sales and marketing force, were willing.

All of the largest concrete block and brick manufacturers responding to the survey indicated the utilization of Type III cement. Type III cement is utilized when high early strength is desired. Fly ash is usually not utilized with Type III cement because fly ash does increase time required for strength development.

The comments of respondents are, as indicated above, informative relative to the potential for utilizing fly ash in this market. For example,

> "We had some delivered from N.E.E.S., but we haven't tried it. Will you pay us to make a test run?"
>
> "We tried it years ago and it didn't work."
>
> "It's good, I've heard, for light weight block, but we don't make them."
>
> "We were going to use it 11-12 years ago but the storage bin (for ash) cost too much."
>
> "We tried it years ago but it messed up (SIC) the color of our block."
>
> "The only company that I know of that really tried to use it is in Hooksett, New Hampshire, and their out of business."
>
> "Never heard it could be used until very recently, haven't tried it yet."

Overall, the responses indicate the following:

1. The cement block and brick manufacturers market for fly ash is largely uneducated as to the potential savings by utilizing fly ash.
2. The market potential is seriously restricted given the use of Type III cement.

3. Past experimentation by a few manufacturers left them unconvinced relative to the value of using fly ash as a cement replacement.

4. Most concrete block and brick manufacturers look upon the potential as an additional burden in terms of production quality control and inventory requirements.

On the basis of current use, an estimated annual average of 40,000 - 50,000 tons of cement are currently utilized in manufacturing concrete block and brick in Massachusetts. If national replacement rates are used, twenty (20) percent of the cement used in block and brick manufacture can be substituted for by fly ash. This would indicate a minimum market potential of 8,000 - 10,000 tons of fly ash in this market. However, given the low potential utilization it is questionable if much effort should be expended to create this market. Therefore, in terms of summary market potential the contribution of cement replacement by fly ash in concrete block and brick manufacture will be ignored.

6. Concrete Products (Except Block) (S.I.C. - 3272)

There are forty-eight (48) manufacturers of concrete products, excluding block, in Massachusetts. These companies employ as few as five (5) and as many as three-hundred and fifty (350). The products produced vary and include:

(a) Pre-cast stairs
(b) Pre-cast walls. (Reinforced)
(d) Burial Vaults
(e) Septic Tanks
(f) Various pre-cast products.
    (Cesspool covers, poles, etc.).

Utilizing known quantitites of cement imported into Massachusetts and national average utilization rates, approximately 68,000 to 78,000 tons of cement are utilized by the concrete products industry in Massachusetts on an annual basis. Assuming a minimum substitution rate of 20 percent, the total market potential for the replacement of cement by fly ash in concrete products is approximately 13,600 - 15,600 tons. However, as with concrete block and brick, there are a large number of small producers of concrete products. The costs associated with the marketing and distribution of fly ash to many small producers may diminish the potential in this market.

The analysis herein has taken the approach of assessing fly ash utilization in those areas wherein the highest quantity of ash can be re-cycled. In keeping with this, the largest producers of precast products were surveyed by telephone to assess market potential. As previously noted, select statements made by representatives of these producers provide insight into market potential. In this market, the following comments are representative of overall response:

> "Never heard of the potential."
>
> "We tried it twenty-five (25) years ago and found it makes the workplace dirty."
>
> "It's been mentioned, but we've never tested it."
>
> "We want to use it (fly ash), but everytime we try we run into (fly ash) quality control problems."
>
> "We are a subsidiary of a national company and they set the specs. on ingredients. They never mentioned fly ash, but I'll bring it up."

Basically, the statements made by respondents indicate:

1. A lack of understanding or knowledge of the potential for fly ash as a cement replacement.
2. Select companies are subject to corporate guidelines which establish mix standards. Thi indicates the value of membership in, and the activity of, the National Ash Association in creating industry awareness of the value of fly ash as a cement substitute.
3. Fly ash quality control continues to be of significant import.

Based upon the telephone survey, it is estimated that the top five manufacturers in Massachusetts, (determined by employment size), utilize approximately seventy-five (75) percent of all cement utilized in this industry.[13] With appropriate marketing, approximately 10,200 - 11,700 tons of fly ash could potentially be utilized by this industry.

7. Economics of Fly Ash Use in Cement Products, Except Block

As indicated previously, it is estimated that cement costs approximately $61.36 per ton, delivered, in Massachusetts. (1982). Assuming delivery will be required and the market can be created, BECo. could sell its fly ash for $11/ton, delivered. This assumes a $4 per ton delivery cost. Excluding delivery cost, BECo. could charge approximately $7 per ton for fly ash. (1982).

If the market for fly ash is created within the cement products manufacturing industry, BECo. could conservatively earn on an annual basis a gross revenue of $71,400 to $81,900 from the sale of ash to this market. In addition, BECo. could save $42,300 to $48,500 in transportation-for-disposal costs. In addition, by reutilizing ash the life of any landfill site is extended. Although reuse raises the per-ton-disposed cost of development of the disposal site it represents a positive net benefit which is not assessed. Given the extended life, BECo. may choose to elect to accept fly ash from other producers. Such acceptance would be based on maintaining adequate landfill capacity to meet BECo.'s future needs as well as compensation commensurate with the market value of the service being provided.

---

[13] Estimate based upon reported Portland Cement orders for average month for 1982. Discussions with J. Whippen, BECo., Jan.-Feb., 1982.

Summary: Fly Ash utlization in cement and concrete products.

The most significant uses of fly ash in cement and concrete products have been addressed. The potential for use in roadway construction will be assessed below. Table F below provides a summary of potential reuse and estimated gross revenues from such reuse as well as disposal costs saved.

Table F
Boston Edison
Fly Ash Market Potential
Cement and Concrete Products

	Potential Fly ash Use/Tons per year	Annual Estimated Gross Revenue (1982)	Annual Disposal Cost Savings
Ready Mix Concrete	133,000	$ 931,000	$550,000
Concrete Block & Brick	(8,000 - 10,000)	N.A.	N.A.
Concrete Products	10,900	$ 76,00	$ 45,400
TOTAL	143,900	$1,007,600	$595,400

C. Fly Ash Utilization - Structural Fill

The largest potential reuse of fly ash, other than in cement and concrete products, is found in reuse for structural fill. Of total ash utilized in 1980, over fifteen (15.6) percent was used as structural fill.

Fly ash has been utilized extensively as a low cost structural fill in Europe for many years. It's use in the United States has been limited to a few states, such as West Virginia, where fly ash abundance for many years stimulated experimentation in alternative use. The single greatest advantage to a utility in enhancing the utilization of fly ash as a structural fill is found in the fact that quality control of ash becomes less of a problem. However, this does not mean the elimination of the need to meet various standards. There are specific physical and engineering properties which must be recognized and tested[14] for if fly ash is to be used as structural fill. These properties are:

1. Grain size distribution
2. Moisture content
3. Shear strength
4. Compressibility
5. Permeability
6. Capillarity
7. Frost susceptibility

In addition to the above, the problem of leachate must be addressed. Reference F provides tables indicating leachate characteristic ranges of fly ash, ranges of an ash solids analysis and ranges of laboratory leachate test data. Although studies have shown that "concentrations of trace elements in fly ash leachates were low, in many cases near the detection limit of current analytical methods," and, "typical soils ranging in classification from clays to sands were capable of attenuating a large percentage of the trace elements"[15], BECo. will have to conduct its own experiments utilizing fly ash as a structural fill before it will be able to convince the construction materials market to accept the material.

It is nearly impossible to determine the current market for fly ash as a structural fill. However, it is known that the supply of structural fill materials is severely limited around Boston. This is witnessed by the fact that structural fill utilized at Boston's Logan Airport had to be imported from New Hampshire. In addition, many of the borrow pits around

---

[14] A complete analysis and ASTM testing requirements for each of these properties is provided in EPRI E.A.-1281 Fly Ash Structural Fill Handbook, December 1979, see Reference F.

[15] EPRI E.A.-1281, Pp. 3-23.

Boston have been closed as towns have become increasingly more protective of the natural material deposits and land resources available within their political boundaries.[16]

There are two fundamental reasons for utilizing fly ash as structural fill:

1. Fly ash has a low unit weight compared to other materials, therefore transportation costs can be reduced.

2. The compaction characteristics of fly ash are normally superior to alternative natural materials.

Assuming BECo. establishes a market for fly ash as a structural fill which meets DEQE requirements, and that the quantity of fly ash so marketed meets the national average, a potential to market approximately 2,370 tons of fly ash as structural fill exists. This would save approximately $9,800 in disposal costs per year assuming those accepting the fill material pay for transport costs.

D. Fly Ash Utilization - Aggregate

Massachusetts ranks second in crushed stone output and third in dimension stone output in New England. Crushed stone is produced in eleven (11) of the state's fourteen (14) counties. Of the 7.3 million tons of crushed stone produced in 1980, 5.8 million tons were traprock. Two-thirds (2/3) of traprock output, or 3.8 million tons, is sold for aggregate. In addition to traprock, other stone, such as granite, is quarried and sold for aggregate. In total, in 1980, Massachusetts produced and sold 4.98 million (short) tons of aggregate with a market value of $14,439,000 or $2.90 per ton.[17]

The utilization of fly ash for aggregate production is advanced in Europe as compared to the U.S. In England, Lytag operates three plants which transform fly ash into aggregate. Their newest plant is located one-mile from the Central Electricity Generating Board's 2000 MW coal fired generating plant in Eggborough, Yorkshire. This single plant annually converts 280,000 tons of fly ash, which is pumped pneumatically from the generating plant 24 hours per day, into Lytag aggregate.

The single greatest advantage of fly ash aggregate is found in its light weight. It's utilization in structural concrete has met all strength requirements while being only two-thirds (2/3) the weight of normal concrete. This weight reduction allows significant savings in building costs because foundations, structural members and reinforcing steel can be reduced. In addition to being used as construction material, the aggregate has proven to be of benefit in horticultural use as a chemically inert agent which retains moisture (up to 30% of its own weight) and assists in drainage. Further, Lytag aggregate has been utilized as an emergency arrestor for trucks and aircraft. The Lytag is placed along roadways in culverts and at the end of airport runways for this purpose. Given its texture, Lytag absorbs spilt kerosine and gasoline, substantually reducing fire risk in accidents.

---

[16] Discussions with contractors and sand and gravel companies by J. Whippen, BECo., Jan.-Feb. 1983.

[17] U.S. Bureau of Mines, Minerals Yearbook, Pre-print, 1981.

Lytag has expressed interest in entering the U.S. market to produce Lytag aggregate. At the same time, there are American companies (G. & W.H. Corson) which are producing lightweight aggregate from coal ash. It is not possible to assess the market potential for this product without definitive, and as yet unavailable information on production costs. As indicated above, Massachusetts does not suffer from a lack of aggregate materials. The potential for substitution of fly ash aggregate for traprock and other aggregates does not appear great. Economic information on the potential could not be developed because as with structural fill, all firms contracted indicated that potential supplies and pricing were proprietary data which they were unwilling to provide, except on a price per truck-load basis which was not believed to be of value. Therefore, estimates for reuse in this category have not been added into the total potential reuse.

E. Fly Ash Utilization - Miscellaneous

As indicated in Table B there are many other uses for fly ash beyond those noted above. However, the potential for significant ash use in each of these categories is limited. Based upon national averages, the total potential usage for all other categories of use represents a potential reuse of 3,000 tons of fly ash. These uses, including potential metal recovery, sanitary land-fill cover, soil amelioration, and as a diotomacious earth replacement in filtering sewage sludge, are still largely experimental.

The potential economic value of miscellaneous use is open to question. Assuming 3,000 tons could be used for miscellaneous purposes its value is equal, at a minimum, to $12,500. This estimate is based upon the avoided transportation cost of transporting fly ash to a disposal site.

F. Summary: Fly Ash Utilization

Table G provides a summary of the potential reuse and market value of fly ash currently determined. This summary does not include the potential for total reuse indicated to be possible by survey respondents. Rather, the data provided are considered conservative even though the survey indicates the potential to reuse seventy nine (79) percent of all fly ash produced. The limit of meeting specifications must not be forgotten in utilizing this estimate.

TABLE G
SUMMARY OF FLY ASH REUSE POTENTIAL

Use Category	Potential Tons/Yr.	Annual Estimated Gross Revenue	Annual Disposal Cost Savings
Cement & Concrete	143,900	$1,007,600	$595,400
Structural Fill	2,370	-	9,800
Miscellaneous	3,000	-	$ 12,500
TOTAL	149,270	$1,007,600	$617,700

Section V: Bottom Ash - Utilization

As indicated in Reference A, the majority of uses of boiler ash are related to highway construction. Of the thirty-nine (39) percent of bottom ash utilized commercially in 1980, over fifty (50) percent was used as road-base or in bituminous cement for roadbase. The next single largest use, which accounted for twenty-nine (29) percent of all bottom ash used commercially, was as snow and ice control material, blasting grit and roofing granules - i.e., as a gritty substance.

A. Road Base and Bituminous Concrete

Bottom ash and fly ash has been most successfully utilized as an aggregate for road base and subbases in West Virginia. It has been used as a partial replacement for asphalt and portland cement or as an aggregate mixed with lime for base and subbase construction.

There are approximately twenty-six (26) companies in Massachusetts which produce and supply paving mixtures and blocks (S.I.C. 2951) and asphalt felts and coatings (S.I.C. 2952). These firms vary significantly in size, employing as many as 2,200 to as few as 6. As in previous potential applications, a sample consisting of eight (8) of the largest employers and select smaller employers were contacted and surveyed by telephone. The purpose of the survey was to determine past, current and potential future usage of fly ash and bottom ash in asphalt (bituminous concrete) and asphalt products.

It was determined from the survey that only one company (a large asphalt producer) has attempted to utilize bottom ash in asphalt production. The remaining firms have not nor do they currently plan to utilize ash. All companies, save one, were aware of the potential but had not pursued it up to this point in time. The single company which had pursued the utilization of bottom ash determined that a change in mixing machinery was needed but felt the change would be economic. Surprisingly, the company representative indicated that the local Board of Health denied the company an application to store coal ash for use in manufacturing. It is surprising because under Massachusetts Law, as indicated previously, local Board of Health approval is not needed to store what the state has declared to be a natural resource.

Further, in discussions with manufacturers it was determined that State Department of Public Works Specifications do not allow coal ash use in highway construction. It was stipulated by the D.P.W. that it does not necessarily disallow such a use, rather, it just has not yet been done[18]. It was further stipulated that the issue needed to "be pushed" a little to bring an adjustment in state D.P.W. specifications to allow coal ash use.

---

[18] Discussion with Massachusetts D.P.W., Specifications Division with J. Whippen, Boston Edison Company (BECo.), February 10, 1983.

The current producers of asphalt, as has been determined with many other products in which ash may be utilized, are to a large extent not aware of the potential for ash use in asphalt production. Therefore, the market for ash use in this segment must be created. The single company which has attempted to use ash is still highly interested in its potential as an economical substitute for other aggregates used in asphalt, and in road construction generally as a subbase material.

Reference G provides three studies which outline the properties and potential constraints of utilizing fly ash and bottom ash in various mixes for road base construction.

The only method available to estimate potential use of bottom ash in this use category is to utilize national utilization rates. Given that this market for ash use is highly undeveloped one could view these estimates as conservative. Based upon national average utilization, approximately ten (10) percent of bottom ash produced, or 6,136 tons, and five (5) percent or 11,850 of fly ash may potentially be utilized per year for road construction. The degree to which this is a conservative estimate can be judged by comparing it to National Ash Association (NAA) estimates of ash utilization potential in constructing one (1) mile of highway. The NAA estimate assumes:

2 - 12' wide berms
2 - 8' wide berms

ACTIVITY	Potential Ash Use
6" Pozzolanic sub-base	470-950 tons
10" Fly ash concrete	200 tons
1" Fly ash asphaltic wearing (Boiler ash potential also)	25-40 tons
6" Berm sub-base (Fly and bottom ash potential)	300-600 tons
1" Bottom ash asphalt Wearing surface	65 tons
Total Ash use for one mile	1,060 to 1,845 tons

Given the NAA estimate, utilizing a total of approximately 18,000 tons of bottom and fly ash as an estimate of what BECo. may be able to market for road construction does not appear unreasonable. The economics involved in this ash use category cannot be readily determined. This is because as a substitute for road construction materials the utilization of ash varies widely. However, assuming ash could be sold for a minimum of $2.00 per ton for combined various uses does not appear unreasonable[19]. Therefore, ash marketed for road use would produce, at a minimum, $36,000 in annual revenue. In addition, approximately $74,700 would be saved annually in disposal transportation costs, assuming an average of $4.15 per ton for such costs.

---

19. Estimate based upon 1981 average per ton price of aggregate.

B. Abrasive

Wet bottom furnaces produce a bottom slag which can be further processed into an abrasive agent known as "Black Beauty". Black Beauty is utilized as an abrasive agent in sandblasting and in making roofing materials. There has been and continues to be a shortage of this material.

There is a potential that under high temperature combustion conditions bottom ash can be utilized for the same purpose as Black Beauty. All potential users of bottom ash who market Black Beauty are highly interested in a potential local supply. Currently there is only one company in New England providing the product. If such a product became available through BECo. it would significantly enhance regional competition.

One potential user indicated a strong willingness to test the bottom ash to see if it could meet the requirements of Black Beauty[20]. If the product does meet such requirements, the producer indicated a desire to establish a plant to grind and bag the product as close to BECo.'s plants as possible. Therefore, this one producer would wish to take all bottom ash output produced which meets specifications. (Note: This same producer would also wish to take as much fly-ash as possible if it meets ASTM specifications for cement use. The producer currently manufacturers a bagged cement product sold for "handyman" use).

Black Beauty currently sells for $21/ton F.O.B. plant, $32/ton bagged. BECo. would have the choice of selling the ash to a producer for approximately $10/ton, joint-venturing a full production process to manufacture Black Beauty or going into the business itself, depending upon the flexibility of corporate structure. Assuming BECo.'s bottom ash from one plant (e.g. Mystic 4, 5 and 6) meets specification, the 23,000 tons of bottom ash sold would produce $230,000 in annual revenues and save an additional $95,450 in disposal transportation costs. However, as with other potential uses of ash the key question will be whether or not the ash meets specifications for the intended use. The above assumes implicitly that only 40 percent of bottom ash produced will meet specification requirements. This is considered an mid-point estimate, i.e., neither conservative nor highly optimistic.

C. BOTTOM ASH - MISCELLANEOUS USE

Bottom ash can be utilized for a number of miscellaneous purposes. One use in particular holds realistic promise; bottom ash as an ingredient in the production of asphalt roofing. Although not currently used by the largest manufacturer of roofing in Massachusetts, the manufacturer indicated the following[21]:

> "We would be willing to use it if the price is right. It would have to be less costly than crushed stone we now produce ourselves. If it was equivalent to Black Beauty it could be used on shingles but would require a color change in our shingles. If the supply was consistent, we would be willing to change our color line."

---

[20] Discussion with J. Whippen, BECo., March 2, 1983.

[21] Conversation with J. Whippen, BECo., March 3, 1983.

The advantage of this use category is that only one specification would have to be met to use bottom ash to replace crushed stone in the production of shingles. The key requirement would be that the ash pass a number eleven (11) gradation mesh screen. If this is met, the manufacturer indicated they could utilize 10,000 tons per year.

The economics involved in this potential application could not be determined. The manufacturer indicated a desire to discuss an arrangement once the ash specifications have been determined. However, for obvious reasons they were unwilling to discuss pricing, nor would they indicate their internal price for the crushed stone the bottom ash would replace.

The last potential use for bottom ash which holds promise to the extent that large quantities may be reutilized is as an ice and snow control agent on roadways. Bottom ash has been used as a replacement for sand in many other states and has been used in New England in the past.

The Massachusetts State engineer for snow and ice control noted that the state does not utilize sand except as a ballast for ice and snow control. The cost of clean-up is such that it is more economical to utilize a pure salt application. The state had experimented with the use of bottom ash "sometime in the past few years" and found the particles to be too fine. The material caused clogging in conveying and spreading machinery[22].

The City of Boston's Chief Road Engineer noted that just as the state, Boston utilizes pure salt except under long term extremely cold conditions. However, the Chief Engineer noted that Boston has purchased K-crete (fly ash asphalt) for use on the repair of two bridges where weight has been a problem. The K-crete is lighter weight than traditional materials. When informed of other road construction uses the engineer indicated a strong willingness to experiment with fly and bottom ash in road construction applications, "especially if it saves us money[23]."

As with other potential markets, it appears that significant educational efforts will have to be undertaken if the market for bottom ash is to be created.

D. Summary: Bottom Ash Utilization

Table H below provides a summary of potential bottom ash re-use. Unlike fly ash use, quantification of bottom-ash reuse proved difficult due to limited research into its applications. However, once bottom ash becomes available there appears enough market interest that higher levels of reuse are likely.

---

[22] Conversation with J. Whippen, BECo., March 3, 1983.

[23] Conversation with J. Whippen, BECo., March 4, 1983.

TABLE H
SUMMARY OF
BOTTOM ASH REUSE
POTENTIAL

Use Category	Tons/Year	Market Value	Disposal Costs Saved
Road Construction	6,136	$ 12,272	$ 25,465
Abrasive	23,000	$230,000	$ 95,450
Total	29,136	$242,272	$120,915

The above use is highly dependent upon meeting existing specifications in each use category. The estimate of use, assuming specifications are met, is a mid-point estimate, i.e., neither conservative nor optimistic. If this use potential is met, sixty three (63) percent or all bottom ash produced could be utilized.

Section VI Summary: Ash Utilization

The potential for utilizing ash as a resource rests upon three factors:

1. Quality control of ash.
2. Creating the market.
3. Eliminating artificial barriers to use.

Quality control of the ash produced in the combustion of coal is a necessity. If the ash meets quality specifications, it will be due to efficient control of all factors influencing the combustion of coal. Given the Boston Edison Company's (BECo.) commitment to energy efficiency as witnessed by its high national ranking in heat rate control, quality control of ash should not present insurmountable problems.

Creating the market will required a corporate commitment to educate potential end-users of ash to the benefits and costs of ash use by category of application. A program of education and joint-testing of ash in various applications will have to be developed if the market is to be effectively created. Given the potential savings inherent in an effective ash marketing program, a commitment to continue developing a full scale ash marketing program appears beneficial.

Eliminating artifical barriers to the use of ash requires a commitment to joint efforts by BECo. and the DEQE as well as other branches of state government. This commitment would take the direction of stimulating changes in specifications to allow and promote the use of ash as a substitute for other, more costly materials. Given the many cooperative efforts between industry and government evolving in today's economy, such a commitment should prove achievable and beneficial.

If the constraints which affect the utilization of ash can be offset, BECo. could expect to annually market about 178,000 tons of ash produced. Although highly optimistic by national standards, given regional material constraints marketing such a quantity is a realistic goal.

REFERENCES

References

A. Fly Ash Production and Use: National Ash Association.

B. Electric Utility Coal Combustion By-Products: A Resource For Recovery and Utilization, Enviroshere Company, September, 1981.

C. EPA Final Guidelines for Federal Procurement of Cement and Concrete Containing Fly Ash.

D. Massachusetts House Bill 4596, Fly Ash Utilization

E. (1) Properties and Use of Fly Ash in Portland Cement Concrete, Tennessee Valley Authority, February 1979 Technical Report CR-79-2.

(2) Properties of Portland Cement Concretes Containing Possolanic Admixtures, U.S. Federal Highway Administration, April 1981. Report No. FHWA/RD-80/184.

(3) Fly Ashes in Cements and Concretes: Technical Needs and Opportunities. by Frohnsdorn, G., Clifton, J. R. U.S. Department of Commerce, National Bureau of Standards, NBSIR 81-2239

(4) Fly Ash as a Component in Concrete, Rose J. G., and Floyd, R. K., Institute for Mining and Minerals Research, University of Kentucky, (No date).

(5) Fly Ash in Structural Concrete, Larsen, T. J. and Harper, L. W., Florida Department of Transportation, Technical Report ST 79-1, April, 1979.

(6) How Fly Ash Improves Concrete Block, Ready Mix Concrete, Concrete Pipe, National Ash Association, 1978-1979.

F. Fly Ash Structure Fill Handbook, Electric Power Research Institute, E.A. - 1281, December, 1979.

G. (1) Lime-Fly Ash-Aggregate Mixtures in Pavement Construction, E. J. Barenberg, N.A.A.

(2) Guide for the Design and Construction of Cement Stabilized Fly Ash Pavements, G. A. I. Consultants, Inc. N.A.A.

(3) "Low Cost Pavements: Utilizing Power Plant Ash", Dorsey, J T. and Dorsey, J. E. Presentation to, 1975 ARBA-NACE National Conference on Local Transportation.

APPENDIX G

SEDIMENT SAMPLING AND ANALYSIS PROTOCOL

APPENDIX G

SEDIMENT SAMPLING AND ANALYSIS PROTOCOL

Boston Edison Company (BECO) is proposing to convert its New Boston Station, Units 1 and 2, to a coal-fired power station. The station is located in South Boston, on the Reserved Channel of Boston Harbor. The conversion plans are based on receiving coal via large oceangoing delivery vessels. To accommodate these vessels, dredging of a berthing basin in the station waterfront area is required. An estimated 25,000 cubic yards of dredged material will be removed. BECO proposes to dispose of this material in the Massachusetts Bay Foul Area, an Environmental Protection Agency (EPA) designated interim ocean disposal area.

To support dredging and dredged material disposal permit applications to be submitted to the U.S. Army Corps of Engineers (COE) and the Massachusetts Department of Environmental Quality Engineering (DEQE), BECO performed a two-phase sediment sample collection and analysis program. The first phase was to obtain physical and chemical data; the second phase was for solid phase bioassay and bioaccumulation data.

Sample Collection and Analysis Procedures

Samples were collected from areas where dredging is being proposed as shown in Figure 1. The samples used for the chemical and grain size analyses were collected from the Reserved Channel by taking borings to depths corresponding to the anticipated dredging depths, utilizing a standard, plastic-lined, 2 inch OD split barrel sampler. These specimens were maintained at a temperature of 2° to 4°C until testing.

Bioassay and bioaccumulation test sediment samples were collected from the Reserved Channel utilizing a plastic-lined 2 5/8 inch diameter gravity corer. Reference sediments were collected from the Massachusetts Bay Foul Area utilizing a stainless steel Van Veen benthic grab sampler. All samples were stored at 4°C until used. Maximum sediment storage time was 6 days.

Grain size testing of the Reserved Channel samples was performed by Stone & Webster Engineering Corporation (SWEC) on samples collected by Guild Drilling Company, Inc. The bulk chemical analysis of these same samples was performed by New England Testing Laboratory, Inc. Sampling and analytical procedures were developed based on discussions with COE and DEQE Division of Water Pollution Control (DWPC). Testing procedures used for grain size and bulk chemical analyses are summarized in Table G-1. The solid phase bioassay and bioaccumulation sample collection and analysis were performed by Battelle New England Marine Research Laboratory. As agreed by the DWPC, the solid phase bioassay and bioaccumulation procedures and analytical methodology were based on COE recommendations, as summarized in Table G-2.

TABLE G-1

METHODS USED FOR GRAIN SIZE AND BULK CHEMICAL ANALYSIS OF RESERVED CHANNEL SEDIMENTS

Parameter	Methods	References
Grain Size Analysis (coarse and fine gravel, sand, silt, and clay)	ASTM: D-422 Gravimetric	ASTM[1]
Bulk Specific Gravity	Standard Methods: 213E Gravimetric	APHA[2]; EPA[3,4]
Volatile and Fixed Matter (water, total, and volatile solids)	Standard Methods: 209G Gravimetric	APHA[2]; EPA[3,4]
Oil and Grease	Standard Methods: 503D Chemical/Gravimetric	APHA[2]; EPA[3,4]
Polychlorinated Biphenyls	EPA - 1977 Gas Chromatography	EPA[3,4,5]
Metals		
Sample Preparation	EPA/COE; Standard Methods: 302E	APHA[2]; EPA/COE[6]
Preliminary Digestion	Standard Methods: 302C	APHA[2]; EPA[3,4]
Nitric Acid-Sulfuric Acid Digestion	Standard Methods: 302E	APHA[2]; EPA[3,4]
Analysis	Atomic Absorption	APHA[2]; EPA[3,4]
Arsenic	Standard Methods: 303E	
Cadmium, Chromium, Copper, Iron, Nickel, Lead, Zinc	Standard Methods: 303A	
Mercury	Standard Methods: 303F	
Vanadium	Standard Methods: 303C	

---

[1] ASTM, American Society of Testing and Materials, 1982 Annual Book of ASTM Standards

[2] APHA, "Standard Methods for the Examination of Water and Wastewater," 15th Ed., 1980.

[3] EPA, "Handbook for Analytical Quality Control in Water and Wastewater Laboratories," EPA-600/4-79-019, 1979.

[4] EPA, "Methods for Chemical Analysis of Water and Waste," EPA 625/6-74-003A, 1974.

[5] EPA, "Manual of Analytical Methods for the Analysis of Pesticide Residues in Human and Environmental Samples," 1977.

[6] Environmental Protection Agency/Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material, 1978.

TABLE G-2

METHODS USED FOR THE SOLID-PHASE BIOASSAY AND BIOACCUMULATIONS TESTING OF RESERVED CHANNEL SEDIMENTS

Parameter	Method	Reference
Bioassay	A 10-day, solid-phase (sediment) bioassay of three marine invertebrate species. Marine invertebrates: Palaemonetes vulgaris (Grass Shrimp) Neanthes virens (Sand Worm) Mercenaria mercenaria (Hard-shell Clam) Sediments used for comparison: Reference sediment (Mass. Bay Foul Area) Test sediments (Reserved Channel)	EPA/COE Technical Committee on Criteria for dredged and filled material, "Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters," Environmental Effects Laboratory, U.S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi. July 1977, Second Printing, April 1978.
Bioaccumulation	Surviving animals from the above bioassay determination were depurated for a period of 24-48 hours, depending on type/size of invertebrate. Samples were homogenized (Mercenaria shells were discarded prior to homogenation) Homogenized samples were either frozen for subsequent cadmium and mercury tests or refrigerated to 4°C for organic analyses.	EPA/COE Technical Committee on Criteria for dredged and filled material, "Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters," Environmental Effects Laboratory, U.S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi. July 1977, Second Printing, April 1978.

TABLE G-2 (Cont)

Parameter	Method	Reference
Mercury	Dried sample homogenate was first digested for 2 hours with a 2:1 mixture of heated sulfuric and nitric acids at 70°C in a shaker bath. After cooling, the sample was further digested using tributyl phosphate and potassium permanganate. Prior to analyzing, excess potassium permanganate was reduced with hydroxylamine hydrochloride and diluted with water. Samples along with standard mercury solutions were analyzed by liberating mercury vapor with stannous chloride in hydrochloric acid, and measuring the nitrogen purged mercury vapor with a LDC mercury analyzer which measures the mercury concentration by absorbance at 254 nm.	Breteler, R.J.; Teal, J.M., and Valieba, I, "Retention and Fate of Experimentally Added Mercury in a Massachusetts Salt Marsh Treated with Sewage Sludge." Marine Environmental Research, 5:211-225, 1981.
Cadmium	Dried sample homogenate was ashed at 500°C for 12 hours. Ash residue was dissolved with concentrated nitric and hydrochloric acids on a hot plate, then diluted with deionized water. Just prior to analysis using Atomic Absorption Spectroscopy with graphite furnace atomization, the sample was further diluted with .03 N nitric acid to minimize matrix interferences. The mean absorbance of three injections was compared to a standard calibration curve. Instrument Conditions Volume Injected 20 ul Hollow Cathode Lamp Current 8 ma Wavelength 228.8 nm Silt Width 0.7 nm	Plumb, R.H., Jr., "Procedure for Handling and Chemical Analysis of Sediment and Water Samples," Technical Report EPA/CE-81-1, U.S. Army Engineers Waterways Experiment Station, CE, Vicksburg, Mississippi, 1981

TABLE G-2 (Cont)

<table>
<tr><th>Parameter</th><th>Method</th><th>Reference</th></tr>
<tr><td>Cadmium(Cont)</td><td>Graphite Furnace Program
<table><tr><th>Step</th><th>Temp(°C)</th><th>Time (Sec)</th></tr><tr><td>Dry</td><td>100</td><td>30</td></tr><tr><td>Ash</td><td>250</td><td>30</td></tr><tr><td>Atom</td><td>2,100</td><td>5</td></tr></table></td><td></td></tr>
<tr><td>PCB, DDT, and Aromatic and Aliphatic Hydrocarbons</td><td>Analyses for PCB and DDT were combined with analysis for petroleum hydrocarbons due to sample availability and sample turnaround requirements.

Procedures used were a combination/modification of three referenced procedures.

Digestion/extraction was similar to method cited in Reference 3 which is comparable to the schemes cited in References 1 and 2.

Sample homogenate was digested using excess 0.5 N NaOH in methanol, partitioned against aqueous potassium chloride and extracted into petroleum ether. The petroleum ether phases were concentrated to 2-3 ml by rotary evaporation, then dried over sodium sulfite prior to silica gel chromatography.

Silica gel chromatography method used was very similar to Reference 2.

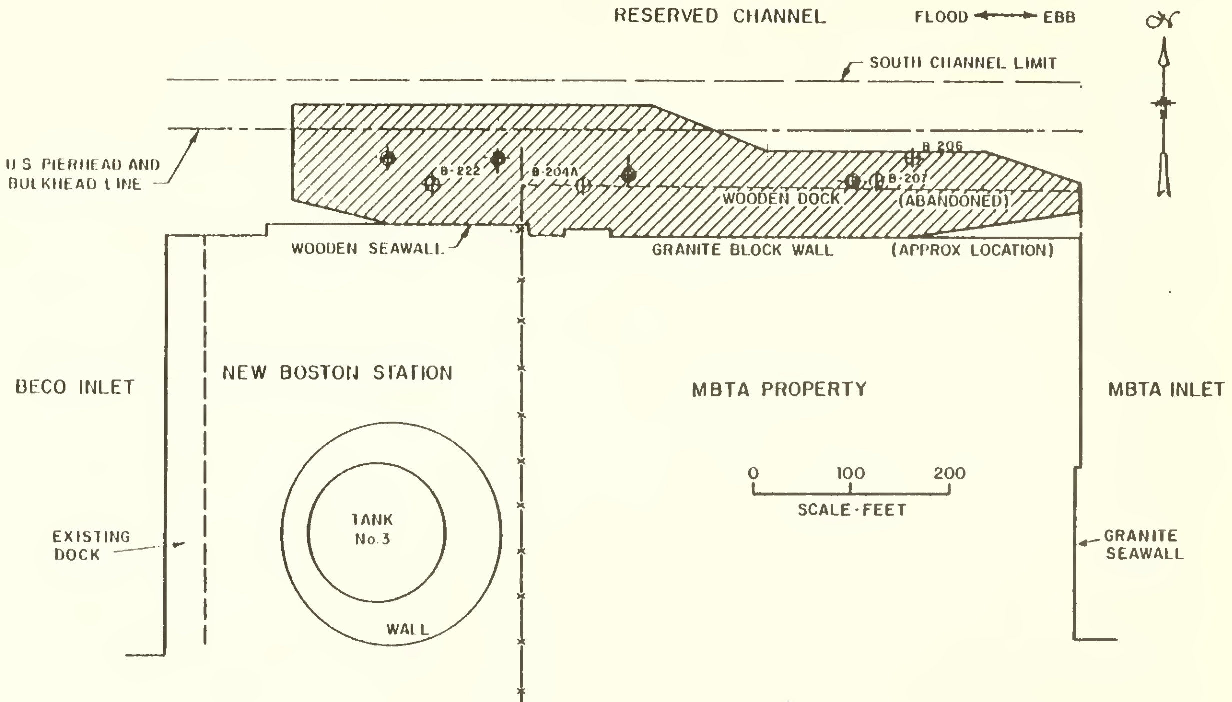
A 15-cm x 1-cm silica gel column eluted with 20 ml of hexane was used to isolate PCB and petroleum hydrocarbons. The collected fraction was concentrated to 1 ml with a rotary</td><td>Reference 1
Thompson, J.F. (Editor), Manual of Analytical Methods, "Analysis of Pesticide Residues in Human and Environmental Samples, EPA, National Environmental Research Center, Research Triangle Park, North Carolina, 1972.

Reference 2
Warner, J.S. "Determination of Aliphatic and Aromatic Hydrocarbons in Marine Organisms." Analytical Chemistry, 48:578-583, 1976.

Reference 3
Boehm et al. Marine Environmental Research, 6:157-188, 1982.</td></tr>
</table>

TABLE G-2 (Cont)

Parameter	Method	Reference
PCB, DDT, and Aromatic and Aliphatic Hydrocarbons (Cont)	evaporator, reduced to almost dryness with a stream of purified nitrogen, then diluted with hexane and capped. Gas chromatography (GC) analysis method used for PCB's and DDT was very similar to Reference 1. Fraction one was chromatographed onto a 3-m x 0.25-mm glass column packed with GP 1.5 percent SP-2250/1.95 percent SP-2401 or 100/.20 supelcoport under the following conditions: Injection Temperature 250°C Column Temperature 200°C Detector Temperature 350°C Carrier Gas Argon-Methane at 30 ml/min Detector Electron capture Injection Volume 2 ul The PCBs were quantified by a summation of peaks using electronic integration. Tetrachlorobiphenyl was used as an internal standard. DDT was calculated from DDE quantified against the internal standard. Gas chromatography analysis method for petroleum hydrocarbons was similar to Reference 2. A 10-foot x 2-mm-ID column packed with 10 percent SP-2100 programmed from 100°-270°C at 6°/min using flame ionization detection was used. Electronic inspection of the GC peaks was used with an N-docosane internal standard.	



LEGEND:

- ⊕ BIOASSAY/BIOACCUMULATION SAMPLE LOCATIONS
- ⊕ BULK SEDIMENT CHEMICAL ANALYSIS SAMPLE LOCATIONS
- ▨ EXTENT OF PROPOSED DREDGING BY BOSTON EDISON CO

FIGURE 1
LOCATION OF TEST SEDIMENT COLLECTIONS
NEW BOSTON STATION-UNITS 1 AND 2
COAL CONVERSION PROJECT

BOSTON PUBLIC LIBRARY
3 9999 06315 551 7